

**3rd Quarterly Report (February - April 1999)**

# Periphyton-Based Stormwater Treatment Area (PSTA) Research and Demonstration Project

**Prepared for:**

**South Florida  
Water Management District**

**Prepared by:**

**CH2MHILL**

**July 1999**



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## SECTION 1

# Introduction

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The South Florida Water Management District (District) is conducting research focused on potential advanced treatment technologies to support reduction of phosphorus loads in surface waters entering the remaining Everglades. Particular focus is being placed on the treatment of excess surface waters from the Everglades Agricultural Area (EAA) as well as the Lake Okeechobee water that is diverted through the primary canal system to the Lower East Coast of Florida.

Periphyton-based stormwater treatment areas (PSTAs) are one of the advanced treatment technologies being researched by the District. The PSTA concept was proposed for phosphorus removal from EAA waters by Doren and Jones (1996) and further described and evaluated by Kadlec (1996, 1998) and Kadlec and Walker (1996). Prior to initiation of the District's PSTA project in July 1998, detailed research to evaluate treatment performance issues and the long-term viability of the PSTA approach to phosphorus reduction in EAA surface waters had not been performed.

The two phases of the PSTA research and demonstration project are described in detail in the *Experimental Research Plan* (CH2M HILL, 1998). In brief, the first phase of the study is to provide basic research data needed to better understand whether PSTAs should remain under the District's investigations as a part of the solution for Everglades restoration. Phase 1 research is being performed through field-based mesocosm experiments located within the District's Everglades Nutrient Removal Project (ENR). Studies are being conducted in 24 portable PSTA mesocosms (Porta-PSTAs), and in three of the south ENR test cells. A second phase of research is planned under which PSTA feasibility will be evaluated further in larger scaled mesocosms. Although preliminary research plan concepts for Phase 2 have been outlined in the *Experimental Research Plan*, they remain dynamic in light of the high level of interest in expediting the overall schedule for evaluating and integrating advanced treatment technologies into the Stormwater Treatment Area (STA) system design for the EAA.

This document is an interim report prepared under Task 9 of the PSTA study program contract held by CH2M HILL. It provides a brief summary of progress on the PSTA Research Project during the third quarter (February through April 1999). As specified in the project scope of work, the quarterly report primarily serves to transmit tabular or graphical summaries of field and laboratory data generated by the project for the subject reporting period.

Prior quarterly reports were limited to summaries of project research planning and field site design and mobilization. The third quarter of the project was the initial quarter of PSTA mesocosm operations. Consequently, this quarterly report differs from the first two reports in that it sets the template for future progress reports. It should be clearly understood that the purpose of these documents is primarily to transmit information. Detailed data interpretation is being deferred for the final report to be prepared after adequate data sets are available to support objective, technically defensible conclusions.

The operational start up of the three ENR PSTA test cells and the Porta-PSTA mesocosms occurred this quarter. Thus, start up corresponded with the winter/early spring, a period of the year when natural periphyton growth occurs at a reduced rate. While this period is not optimal in terms of demonstrating treatment performance, it was appropriate for the project start up in terms of allowing the research to document grow-in patterns and rates, both of which are of concern with respect to PSTA system constructability and viability. However, completion of the 1-year field studies anticipated under Phase 1 will provide the District with a clearer picture on how seasonality affects PSTA "functionality". Therefore, initial operational data presented in this report merely serves to document the startup condition and are not appropriate for supporting conclusions regarding PSTA viability.

Lastly, it should be noted that the information contained in this document remains preliminary and draft. Complete quality control (QC) review of all data sets has not been conducted on all of the information being transmitted (some of it was only recently received from the various analytical support laboratories). Any data identified during our QC reviews that should be flagged or qualified will be documented in future quarterly reports and the final report.

## SECTION 2

# Summary of Progress During Previous Quarters

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PSTA research activities during the first two quarters of the project were focused on development of a peer-reviewed, scientifically valid research plan and implementation of that plan through mesocosm design, construction, and testing. This section provides a bulletized summary of key activities during that period along with an overview of the experimental design produced by those activities.

## First Project Quarter—July 1998 through October 1998

- Scientific Research Panel (SRP) members subcontracted and scheduled to review the PSTA Research Plan
- Preliminary Draft PSTA Research Plan was prepared and submitted to District for review and comment
- Draft PSTA Research Plan was revised and sent to SRP members prior to the review meeting
- PSTA SRP review meeting as held at District headquarters in West Palm Beach
- Oral and written comments on the PSTA Research Plan were received and incorporated in the revised Draft PSTA Research Plan dated October 1998

## Second Project Quarter—November 1998 through January 1999

- Conducted design and contracting for Porta-PSTA construction
- Conducted design of modifications to ENR PSTA test cells and implementation of plant growth inhibition activities
- Developed Porta-PSTA layout at South ENR Supplemental Technologies Research Compound
- Delivered and set-up Porta-PSTAs including site plumbing, leak-testing, sediment installation, macrophyte planting, and algae seeding
- Delivered and set-up PSTA field trailer at South ENR Supplemental Technologies Research Compound
- Modified ENR PSTA Test Cells to include inlet and outlet distribution enhancement, installation of monitoring walkways, installation of feldspar horizon markers, and macrophyte planting

- Developed final methods for water regime fluctuations, periphyton and sediment coring, percent cover estimates, light attenuation studies, and community metabolism studies
- Conducted analytical testing of PSTA sediments for phosphorus sorption/desorption characteristics and inclusion of sand-based controls in Porta-PSTA design

Several of the activities started during the second quarter continued into the third project quarter because of the need for some Porta-PSTA mesocosm leak-proofing and repairs. While this delayed field research start up, this had the side benefit of providing additional time for establishment and growth of the *Eleocharis sp.* planted in both mesocosm types before raising water in the mesocosms to target water levels for operation. In addition, deferral of operational start up reduced the challenge of trying to get the periphyton system operational during the worst season for periphytic algal growth.

## Summary of Experimental Design

### South ENR Test Cells

The District assigned three test cells within the south ENR test cell site to the PSTA Research Project. During final construction, substrate within these PSTA test cells was modified by the District by placing the following layers of substrate over the cell liner:

- Test Cell 3: 3.5 ft of sand surcharge plus 1.0 ft of shellrock (locally mined)
- Test Cell 8: 3.5 ft of sand surcharge plus 1.0 ft of shellrock (locally mined)
- Test Cell 13: 2.5 ft of sand surcharge plus 1.0 ft of shellrock (locally mined) plus 1 ft of peat (taken from area of STA 1W, Cell 5 – unflooded, former agriculturally worked lands)

Exhibit 2-1 provides a plan view of a typical PSTA test cell showing sampling locations and walkways. Exhibit 2-2 provides a view of the actual walkways installed to facilitate monitoring activities within the test cells. Exhibit 2-3 provides a summary of detailed design criteria for the PSTA Test Cells.

### Porta-PSTA Mesocosms

Twenty-four Porta-PSTA mesocosm units were fabricated of fiberglass offsite and delivered to the technology demonstration area near the south ENR Test Cells. Twenty-two of the fiberglass tanks are 6 m long by 1 m long by 1 m deep. The remaining two tanks are 3 m wide to allow assessment of mesocosm configuration effects.

Exhibit 2-4 provides an example Porta-PSTA experimental site plan view showing tank dimensions and general flow of water through the experimental system. Exhibits 2-5 and 2-6 are photographs of a typical Porta-PSTA mesocosm and the constant head feed water tank.

Randomized Porta-PSTA mesocosm/treatment combinations are presented in Table 2-7. Detailed design and operational criteria for the Porta-PSTAs are summarized in Table 2-8.



## **Start Up of Mesocosm Operations**

The ENR PSTA Test Cells were filled to their operational levels and inflows were adjusted to operational hydraulic loading rates on February 15, 1999. All of the major construction/test cell modifications requiring disturbance activities within the cells were complete at that time. Operational monitoring of the PSTA Test Cells began on February 23, 1999.

The Porta-PSTAs were adjusted to operational levels and inflows were adjusted to the operational hydraulic loading rate on April 12, 1999. As noted elsewhere in this report, startup of the Porta-PSTA research was delayed relative to the test cells because of vendor delays in completing mesocosm leak testing, repairs, and delivery.

## **Tables and Figures for Section 2**

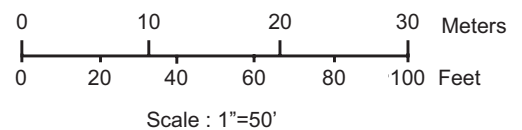
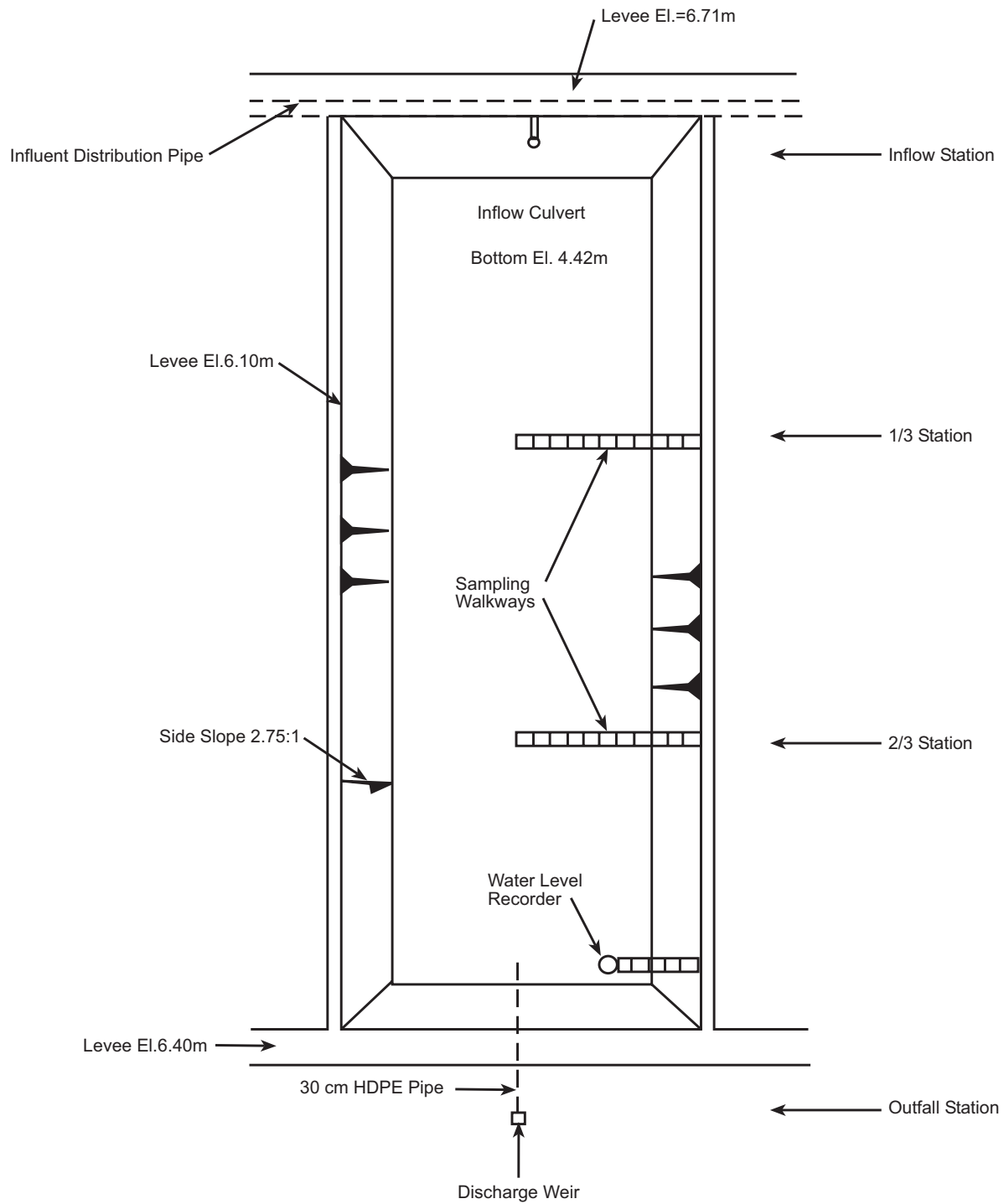


Figure 1. Plan View of Typical ENR PSTA Test Cell Showing Sampling Locations.



**EXHIBIT 2-2**

Monitoring Walkways Located at the 1/3 and 2/3 Points in the PSTA Test Cells.

*PSTA Research Project*

**Exhibit 2-3****Summary of Detailed Design Criteria For ENR PSTA Test Cells**

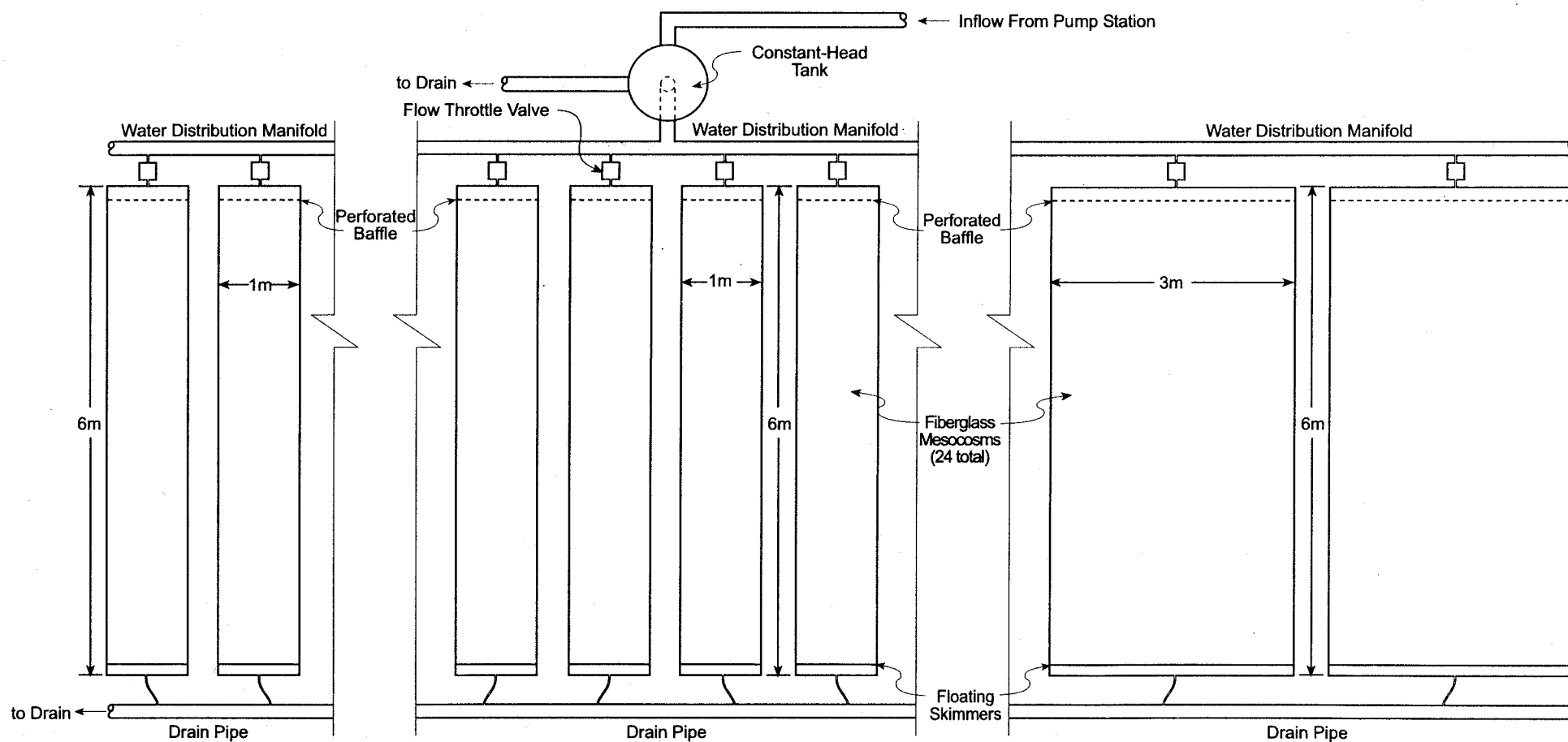
<b>Design Parameter</b>	<b>Cell 3</b>	<b>Cell 8</b>	<b>Cell 13</b>	<b>Combined System</b>
No. Cells	1	1	1	1
Flow (m3/d)				
Average	134	134	134	403
Maximum	269	134	134	538
Minimum	1	134	134	270
Cell Length (m)	80.0	80.0	80.0	80.0
Cell Width (m)	28.0	28.0	28.0	28.0
Aspect Ratio	2.9	2.9	2.9	2.9
Area (m2)				
Horizontal surface area	2240.0	2240.0	2240.0	6720
Wall Area (@ design depth)	64.8	129.6	129.6	324
Operational Water Depth (m)				
Average	0.30	0.60	0.60	0.50
Maximum	1.00	0.60	0.60	0.73
Minimum	0.01	0.60	0.60	0.40
Operational Water Volume (m3)				
Average	672.0	1344.0	1344.0	3360
Maximum	2240.0	1344.0	1344.0	4928
Minimum	22.4	1344.0	1344.0	2710
Nominal Hydraulic Residence Time (d)				
@ average flow and depth	5.00	10.00	10.00	8.33
@ maximum flow and minimum depth	0.08	10.00	10.00	5.04
@ minimum flow and maximum depth	2240.00	10.00	10.00	18.27
Hydraulic Loading Rate (cm/d)				
@ average flow and depth	6.0	6.0	6.0	6.0
@ maximum flow	12.0	6.0	6.0	8.0
@ minimum flow	0.0	6.0	6.0	4.0
Nominal Linear Velocity (m/d)				
@ average flow and depth	16.00	8.00	8.00	28.80
@ maximum flow and minimum depth	960.0	8.0	8.0	47.6
@ minimum flow and maximum depth	0.04	8.00	8.00	13.14
Substrate				
Surface	Shellrock	Shellrock	Peat	Peat/Shellrock
Bottom	Shellrock	Shellrock	Shellrock	Shellrock
Construction Material	Earth	Earth	Earth	Earth
Liner (Yes/No)	Yes	Yes	Yes	Yes
Freeboard (m)				
@ average depth	1.68	1.38	1.38	1.48
Deep Zones				
Number per Cell	0	0	0	0
Depth Below Floor Elevation (m)	NA	NA	NA	NA
Plant Species (Yes/No)				
Periphyton	Yes	Yes	Yes	Yes
Macrophytes	Yes	Yes	Yes	Yes
None (Aquashade Control)	No	No	No	No
Design TP Influent Quality (ug/L)				
Average	40	40	40	40
Maximum	50	50	50	50
Minimum	30	30	30	30
Design TP Mass Loading (g/m2/y)				
Average	0.88	0.88	0.88	0.88
Maximum	1.10	1.10	1.10	1.10
Minimum	0.66	0.66	0.66	0.66

**EXHIBIT 2-4**

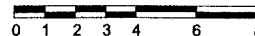
## Randomized Porta-PSTA Mesocosm / Treatment Combinations

*PSTA Research Project*

<b>Treatment #</b>	<b>Substrate</b>	<b>Periphyton</b>	<b>Macro-phytes</b>	<b>Water Depth (cm)</b>	<b>HLR (cm/d)</b>	<b>Width (m)</b>	<b>Tank #</b>
1a	Peat	Yes	Yes	60	6	1	9
1b	Peat	Yes	Yes	60	6	1	11
1c	Peat	Yes	Yes	60	6	1	18
2a	Shellrock	Yes	Yes	60	6	1	7
2b	Shellrock	Yes	Yes	60	6	1	4
2c	Shellrock	Yes	Yes	60	6	1	8
3a	Peat	Yes	Yes	30	6	1	17
3b	Peat	Yes	Yes	30	6	1	14
3c	Peat	Yes	Yes	30	6	1	12
4a	Shellrock	Yes	Yes	30	6	1	10
4b	Shellrock	Yes	Yes	30	6	1	5
4c	Shellrock	Yes	Yes	30	6	1	3
5a	Shellrock	Yes	Yes	60	12	1	16
5b	Shellrock	Yes	Yes	60	12	1	2
5c	Shellrock	Yes	Yes	60	12	1	13
6a	Shellrock	Yes	Yes	0-60	6	1	6
6b	Shellrock	Yes	Yes	0-60	6	1	15
6c	Shellrock	Yes	Yes	0-60	6	1	1
7	Sand	Yes	Yes	30	6	1	20
8	Sand	Yes	Yes	60	6	1	19
9	Peat	No	No	60	6	1	21
10	Shellrock	No	No	60	6	1	22
11	Shellrock	Yes	Yes	30	6	3	23
12	Peat	Yes	Yes	30	6	3	24



Approximate Scale in Feet



Approximate Scale in Meters

**Exhibit 2-5. Portra-PSTA Experimental Mesocosm Site Plan**



**Exhibit 2-6.** Typical Porta-PSTA at startup showing fiberglass tank construction.  
*PSTA Research Project*





**Exhibit 2-7.** Twenty-four Porta-PSTA mesocosms are arrayed around a constant-head feed water tank.

*PSTA Research Project*

**Exhibit 2-8**
**Summary of Design Criteria For Porta-PSTA Experimental Mesocosms**

Design Parameter	Treatment 1	Treatment 2	Treatment 3	Treatment 4	Treatment 5	Treatment 6	Treatment 7	Treatment 8	Treatment 9	Treatment 10	Treatment 11	Treatment 12	Combined System
No. Cells	3	3	3	3	3	3	1	1	1	1	1	1	24
Flow (m3/d)													
Average	0.36	0.36	0.36	0.36	0.72	0.36	0.36	0.36	0.36	0.36	1.08	1.08	11.16
Maximum	0.36	0.36	0.36	0.36	0.72	0.72	0.72	0.36	0.36	0.36	1.08	1.08	12.60
Minimum	0.36	0.36	0.36	0.36	0.72	0.05	0.05	0.36	0.36	0.36	1.08	1.08	9.92
Flow (mL/min)													
Average	250	250	250	250	500	250	250	250	250	250	750	750	7750
Maximum	250	250	250	250	500	500	500	250	250	250	750	750	8749
Minimum	250	250	250	250	500	35	35	250	250	250	750	750	6888
Cell Depth (m)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Cell Length (m)	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00
Cell Width (m)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	3.00	3.00	1.33
Length:Width Ratio	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	2.0	2.0	4.5
Water Depth:Width Ratio	0.6	0.6	0.3	0.3	0.6	0.3	0.3	0.6	0.6	0.6	0.1	0.1	0.34
Area (m2)													
Horizontal surface area	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	18.00	18.00	168.00
Wall Area (@ design depth)	8.40	8.40	4.20	4.20	8.40	4.20	4.20	8.40	8.40	8.40	5.40	5.40	153.60
Operational Water Depth (m)													
Average	0.60	0.60	0.30	0.30	0.60	0.30	0.30	0.60	0.60	0.60	0.30	0.30	0.45
Maximum	0.60	0.60	0.30	0.30	0.60	0.60	0.30	0.60	0.60	0.60	0.30	0.30	0.48
Minimum	0.60	0.60	0.30	0.30	0.60	0.01	0.30	0.60	0.60	0.60	0.30	0.30	0.43
Operational Water Volume (m3)													
Average	3.60	3.60	1.80	1.80	3.60	1.80	1.80	3.60	3.60	3.60	5.40	5.40	72.00
Maximum	3.60	3.60	1.80	1.80	3.60	3.60	1.80	3.60	3.60	3.60	5.40	5.40	77.40
Minimum	3.60	3.60	1.80	1.80	3.60	0.06	1.80	3.60	3.60	3.60	5.40	5.40	66.78
Nominal Hydraulic Residence Time (d)													
@ average flow and depth	10.00	10.00	5.00	5.00	5.00	5.00	5.00	10.00	10.00	10.00	5.00	5.00	6.45
@ maximum flow and minimum depth	10.00	10.00	5.00	5.00	5.00	0.08	5.00	10.00	10.00	10.00	5.00	5.00	5.30
@ minimum flow and maximum depth	10.00	10.00	5.00	5.00	5.00	72.00	5.00	10.00	10.00	10.00	5.00	5.00	7.80
Hydraulic Loading Rate (cm/d)													
@ average flow and depth	6.0	6.0	6.0	6.0	12.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.6
@ maximum flow	6.0	6.0	6.0	6.0	12.0	12.0	6.0	6.0	6.0	6.0	6.0	6.0	7.5
@ minimum flow	6.0	6.0	6.0	6.0	12.0	0.8	6.0	6.0	6.0	6.0	6.0	6.0	5.9
Nominal Linear Velocity (m/d)													
@ average flow and depth	0.60	0.60	1.20	1.20	1.20	1.20	1.20	0.60	0.60	0.60	1.20	1.20	0.95
@ maximum flow and minimum depth	0.60	0.60	1.20	1.20	1.20	72.00	1.20	0.60	0.60	0.60	1.20	1.20	6.85
@ minimum flow and maximum depth	0.60	0.60	1.20	1.20	1.20	0.08	1.20	0.60	0.60	0.60	1.20	1.20	0.86
Substrate Depth (m)	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.20
Substrate Type	Peat	Shellrock	Peat	Shellrock	Shellrock	Shellrock	Sand	Sand	Peat	Shellrock	Shellrock	Shellrock	Peat/Shellrock
Construction Material	Fiberglass	Fiberglass	Fiberglass	Fiberglass	Fiberglass	Fiberglass	Fiberglass	Fiberglass	Fiberglass	Fiberglass	Fiberglass	Fiberglass	Fiberglass
Liner (Yes/No)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Freeboard (m)													
@ average depth	0.10	0.10	0.40	0.40	0.10	0.40	0.40	0.10	0.10	0.10	0.40	0.40	0.25
Plant Species (Yes/No)													
Periphyton	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes/No
Macrophytes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No	Yes	Yes	Yes/No
None (Aquashade Control)	No	No	No	No	No	No	No	No	Yes	Yes	No	No	Yes/No
Design TP Influent Quality (ug/L)													
Average	40	40	40	40	40	40	40	40	40	40	40	40	40
Maximum	50	50	50	50	50	50	50	50	50	50	50	50	50
Minimum	30	30	30	30	30	30	30	30	30	30	30	30	30
Design TP Mass Loading (g/m2/y)													
Average	0.88	0.88	0.88	0.88	1.75	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.97
Maximum	1.10	1.10	1.10	1.10	2.19	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.21
Minimum	0.66	0.66	0.66	0.66	1.31	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.73

## SECTION 3

# Meteorological Data

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## Solar Radiation

Solar radiation is being continuously monitored by CH2M HILL at the South Supplemental Technologies Research Compound using a pyranometer and photosynthetically active radiation (PAR) sensor monitored above the constant-head water tank (Exhibit 3-1). Exhibits 3-2 and 3-3 illustrate total solar radiation and PAR at this site for this quarter. Summary statistics for these parameters during this period are summarized in Exhibit 3-4.

## Rainfall

Daily rainfall data were provided by the District. Exhibit 3-5 illustrates daily total rainfall at the ENR Rainfall Station ENR301 for the February through April 1999 study period. Daily rainfall statistics during this period are summarized in Exhibit 3-6.

## **Exhibits for Section 3**

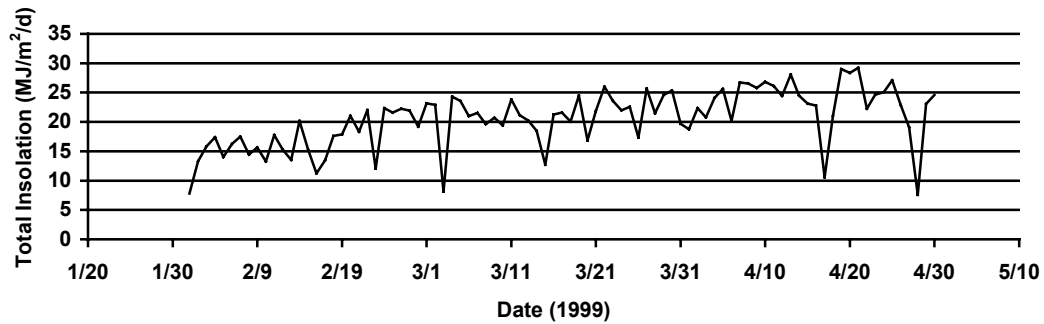


**EXHIBIT 3-1**

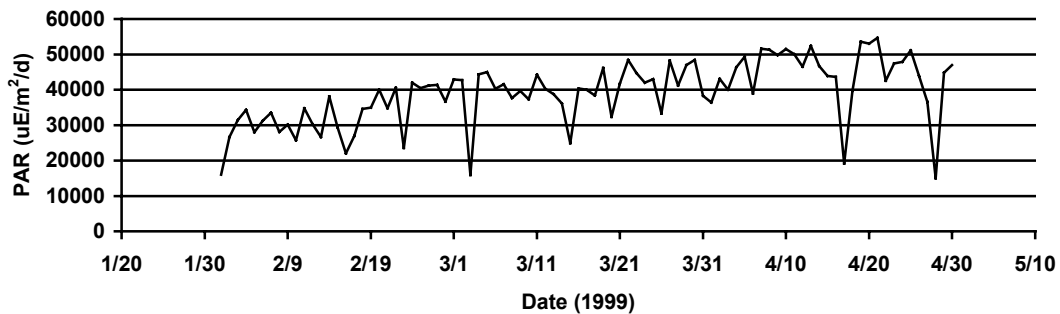
Photograph of Porta-PSTA Head Tank Showing Radiation Sensor Installation and Inlet/Outlet Plumbing  
*PSTA Research Project*

**EXHIBIT 3-2**

Total Solar Radiation at the South ENR Supplemental Technologies Research Compound  
*PSTA Research Project*

**EXHIBIT 3-3**

Photosynthetically Active Radiation at the South ENR Supplemental Technologies Research Compound  
*PSTA Research Project*

**EXHIBIT 3-4**

Meteorological Parameters  
*PSTA Research Project*

Parameter	Avg	Max	Min	Std Dev	Count
Total Insolation (MJ/m <sup>2</sup> /d)	20.50	29.24	7.56	4.91	89
PAR Total (E/m <sup>2</sup> /d)	39.2	54.6	15.0	9.0	89

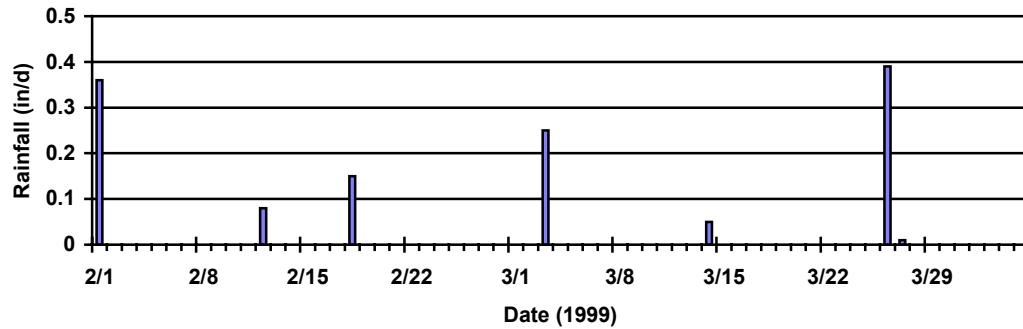
Period of Record: 2/1/99 – 4/30/99

1 J = 0.238 calories

1 E = 52,270 calories

**EXHIBIT 3-5**

Daily rainfall data for the District's Station ENR301  
*PSTA Research Project*

**EXHIBIT 3-6**

Rainfall Summary in the PSTA Research Area  
*PSTA Research Project*

Parameter	Avg	Max	Min	Std Dev	Count
Rainfall (inches/day)	0.02	0.39	0.00	0.08	63

Period of Record: 2/1/99 – 4/4/99

Total Rainfall:  
February 1999 = 0.59 inches  
March 1999 = 0.70 inches



## SECTION 4

# ENR PSTA Test Cells

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## Water Regime

The PSTA water regime includes the components of water depth fluctuations and water mass balance. Continuous water level recorders are to be installed by the District at the upstream and downstream end of each of the ENR test cells, but this has not yet occurred. It is anticipated that those installations and telemetering connections will be completed during the next quarter.

In the interim, water level measurements in the PSTA Test Cells during this quarter were recorded by reading the staff gauge installed by the District near the outflow of each test cell; readings were taken no less than weekly. Stage records for the Head Cell were available on a continuous basis. These stage data were provided by the District.

Water inflows to the PSTA Test Cells are estimated with an empirical equation (Equation 1) that is based upon inlet orifice diameter and the water stage in the Head Cell feeding the three PSTA Test Cells:

$$Q_{in} \text{ (cfs)} = [\text{stage (ft)} * A] - B \quad \text{Equation 1}$$

Where:

0.75-inch orifice:  $A=0.004561$ ,  $B=0.07561$

1.0-inch orifice:  $A=0.008587$ ,  $B=0.14266$

Outflows from the PSTA Test Cells were estimated by applying a flow equation provided by the District for the 90-degree v-notch weirs at each outlet. Water depth values used are the staff gauge readings referenced above. Once the District stage recorders are installed, outflow estimates will be available on a continuous basis.

$$Q_{out} \text{ (cfs)} = 2.50 * H^{2.5} \quad \text{Equation 2}$$

Where:

$H$  = water depth (ft)

Exhibit 4-1 summarizes the PSTA Test Cell water regime data for this quarter. Water level, inflow, and outflow trend charts can be observed in Appendix A. It should be noted that the water depth and inflow data summarized include values preceding the start up of test cell experimental operations. These summary statistics will be adjusted in the future to pertain only to the experimental period during which PSTA operational monitoring is performed.

## Field Parameters

Field parameters (water temperature, pH, dissolved oxygen [DO], percent saturation, and specific conductance) are measured in the PSTA Test Cells on a weekly basis at the inflow



and outflow and once each month at two internal sampling points (1/3 and 2/3 monitoring walkways). In addition, one recording data sonde unit was installed in the Head Cell on April 12, 1999, to continuously document inflow conditions, and one data sonde is deployed on a rotating basis at the monitoring walkways within the test cells. This section summarizes the results from these field parameter measurements

Exhibit 4-2 summarizes the field parameter data during this quarter. Time-series plots of hourly data from Test Cell 3 are provided in Exhibits 4-3 through 4-7 for the parameters listed above. These exhibits are representative of the patterns in the data demonstrated at all three test cells. Detailed trend plots of hourly field parameter data for the third quarter are provided in Appendix B. Diurnal temperature fluctuations were generally in the range of 16 to 24 °C and are due to the diurnal input of sunlight to the PSTA Test Cells. Diurnal fluctuations of DO and pH are a reflection of aquatic primary productivity in the cells (see Community Metabolism section below). No marked diurnal pattern was observed for specific conductance during this period of operation.

## **Laboratory Analyses**

Exhibit 4-8 summarizes the water quality sampling schedule and parameter list for the PSTA Test Cells. Samples are collected at different stations at varying frequency in accordance with the PSTA Research Plan. Phosphorus samples are collected at the highest frequency and are being analyzed by Dr. Ramesh Reddy's laboratory at the University of Florida's Institute for Food and Agricultural Sciences (IFAS). Toxikon Laboratory in Jupiter, Florida is performing the other water quality analyses indicated. Water & Air Research is providing periphyton taxonomic services. PPB Environmental Laboratories is conducting the additional periphyton sample analyses. Key parameter analyses are highlighted as follows.

### **Phosphorus**

Head Cell samples (representing test cell inflows) and test cell outflow samples are collected on a weekly basis for analysis of total phosphorus (TP), total dissolved phosphorus (TDP), and dissolved reactive phosphorus (DRP). Individual cell inflows are monitored monthly and internal stations are sampled quarterly. Total particulate phosphorus (TPP) is estimated in these samples by difference (TP-TDP) as is dissolved organic phosphorus (DOP) which is equal to (TDP-DRP).

Exhibit 4-9 summarizes phosphorus data from the PSTA Test Cells during the first 3 months of operation. TP levels typically increased as water passed through each test cell during this period due to increased levels of TPP. This finding is believed to be related to resuspension of loosely consolidated sediments and export due to wind mixing following startup and prior to significant periphyton establishment (see total suspended solids data referenced below).

### **Nitrogen**

Total nitrogen and major component nitrogen forms are sampled at the Head Cell and at the outflows of the three PSTA Test Cells on a monthly basis. Test cell inflow points and the internal stations are sampled for nitrogen on a quarterly basis. The first 3 months of nitrogen data are summarized in Exhibit 4-10.

A slight decrease in TN concentrations was observed in the PSTA Test Cells during this period. Average concentrations of organic nitrogen, nitrate/nitrite-N, and ammonia (NH<sub>4</sub>-N) declined with greatest reductions in Test Cell 8.

## Other Water Quality Parameters

The PSTA Test Cells are sampled monthly for Head Cell and test cell outlet concentrations of total suspended solids (TSS), total organic carbon (TOC), calcium, and alkalinity. In addition, the test cell inflows and the two internal stations are monitored for these parameters on a quarterly basis. Exhibit 4-11 summarizes the results for these parameters during the first operational quarter.

## Biological Analyses

Biological analyses conducted in the PSTA Test Cells include: plant cover estimates and water column samples that are subsampled for algal identification and counts, biomass, calcium content, chlorophyll (*a*, *b*, *c*, and *phaeophytin*), phosphorus (total, total inorganic, and detailed fractionation), and total Kjeldahl nitrogen.

Exhibit 4-12 provides a summary of the biological results from the PSTA Test Cells generated during this quarter. Exhibits 4-13 and 4-14 are photographs of vegetation growth in the PSTA Test Cells including *Eleocharis* sp. with periphyton/*Utricularia* mix.

## Sediments

Pre-existing and newly deposited soils within the PSTA Test Cells were cored and analyzed from the depth increment 0-10 cm. These samples are analyzed for percent solids and bulk density. Beginning next quarter, sediments will be monitored monthly for these parameters and also analyzed for total and inorganic phosphorus fractions. Analyses of total organic carbon, total Kjeldahl nitrogen, and phosphorus (total, total inorganic, and non-reactive fractionation) will also be conducted on a quarterly basis.

Chemical analyses for sediment samples collected in March 1999 are not yet available from the analytical laboratory; these will be incorporated into the next quarterly report.

Exhibit 4-15 summarizes the average percent solids and bulk density results for each test cell on the basis of the February and April data.

## Community Metabolism

Community metabolism is being estimated using the diurnal DO rate-of-change method. An estimated oxygen diffusion rate constant of 0.05 g/m<sup>2</sup>/d was used for these preliminary metabolism estimates. This diffusion rate will be measured during future study activities, and the preliminary metabolism values presented in this interim progress report will be adjusted during data synthesis for the final report. System parameters that are estimated with this method include:

- Gross primary production (GPP)
- Community respiration (CR)

- Net Primary Production ( $NPP = GPP - CR$ )

Exhibit 4-16 summarizes the community metabolism estimates for the PSTA Test Cells for the period from February through April 1999.

## **Exhibits for Section 4**

**EXHIBIT 4-1**  
PSTA South Test Cells Water Regime Summary  
PSTA Research Project

Parameter	Test Cell		
	3	8	13
Water Depth (m)			
Avg	0.61	0.57	0.58
Max	0.73	0.69	0.66
Min	0.41	0.33	0.35
Std Dev	0.10	0.11	0.11
n	23	23	23
<i>Period of Record: 2/2/99 - 4/30/99</i>			
Inflow (m <sup>3</sup> /d)			
Avg	124.82	137.81	137.81
Max	153.08	153.08	153.08
Min	51.61	51.61	51.61
Std Dev	30.48	18.91	18.91
n	8343	8343	8343
<i>Period of Record: 2/1/99 - 4/30/99</i>			
Outflow (m <sup>3</sup> /d)			
Avg	203.62	123.76	115.67
Max	699.23	191.14	191.14
Min	0.00	53.30	62.63
Std Dev	193.43	31.25	31.50
n	17	15	15
<i>Period of Record: 3/3/99 - 4/29/99</i>			
HLR (cm/d)			
Avg	4.75	5.29	5.30
Max	6.14	6.20	6.25
Min	1.92	1.97	1.95
Std Dev	1.15	0.74	0.75
n	2000	2000	2000
<i>Period of Record: 2/1/99 - 4/29/99</i>			

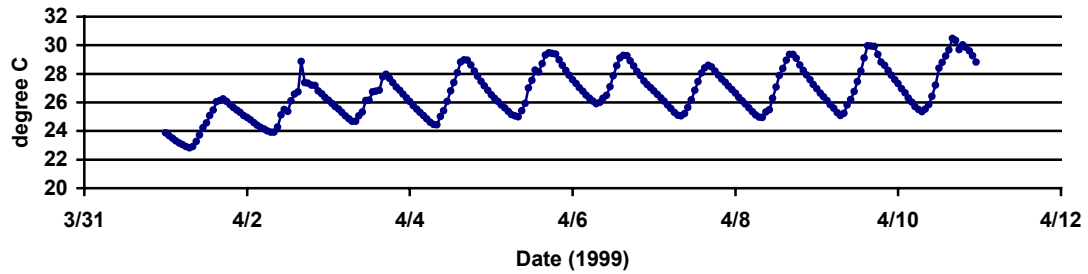
Note: Cell ground elevation = 14.5 ft. for water depth calculation.

**EXHIBIT 4-2**  
PSTA South Test Cell Field Parameter Summary  
PSTA Research Project

Parameter		PSTA Test Cell (all stations)			
		HC	3	8	13
Water Temperature (C)	Avg	26.4	24.2	22.6	23.5
	Min	20.7	16.4	14.2	16.3
	Max	35.6	31.2	33.2	32.4
	Std Dev	1.4	2.8	3.4	3.0
	n	304	1180	2776	1106
pH (units)	Avg	7.9	8.4	8.4	8.6
	Min	7.7	8.3	7.8	7.3
	Max	9.0	8.5	9.1	9.1
	Std Dev	0.1	0.0	0.1	0.2
	n	304	1180	2776	1106
Conductivity (umhos/cm)	Avg	1192	1330	1222	1268
	Min	74	898	849	158
	Max	1390	1423	1383	1329
	Std Dev	154	61	82	64
	n	304	1180	2776	1106
Dissolved Oxygen Saturation (%)	Avg	63.4	95.1	94.2	124.0
	Min	33.5	66.5	34.0	27.5
	Max	96.1	133.1	200.0	200.0
	Std Dev	12.6	11.8	15.1	38.3
	n	145	1083	2776	333
Dissolved Oxygen (mg/L)	Avg	5.0	7.8	8.1	9.4
	Min	2.7	5.6	2.8	2.3
	Max	7.4	10.1	15.9	17.9
	Std Dev	0.8	0.8	1.1	2.0
	n	304	1180	2776	1106
Period of Record (intermittent)		4/12/99	2/17/99	2/1/99	3/3/99
		4/29/99	4/22/99	4/29/99	4/29/99

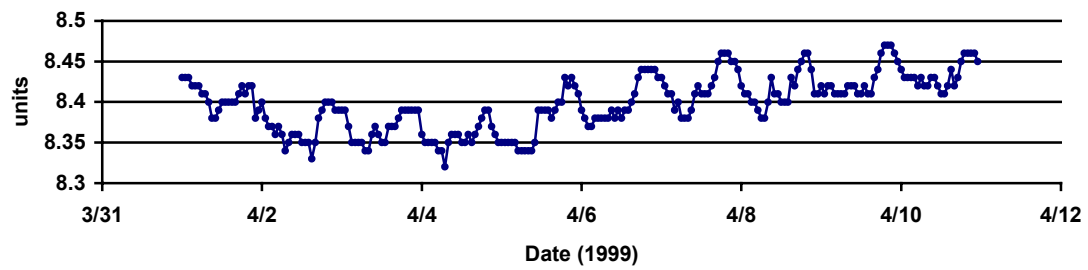
**EXHIBIT 4-3**

Daily pattern of Temperature at PSTA Test Cell 3  
*PSTA Research Plan*



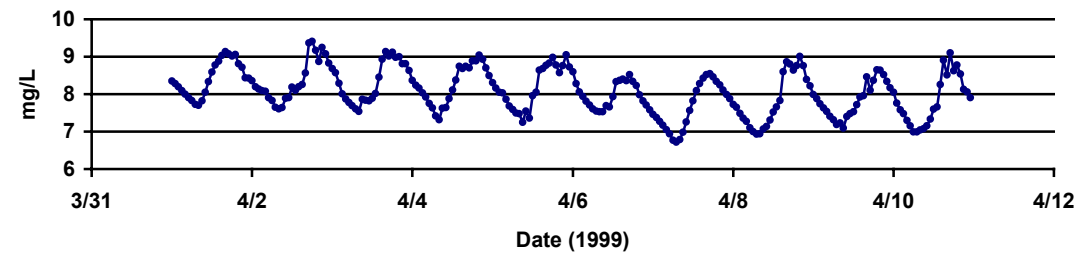
**EXHIBIT 4-4**

Daily Pattern of pH at PSTA Test Cell 3  
*PSTA Research Plan*



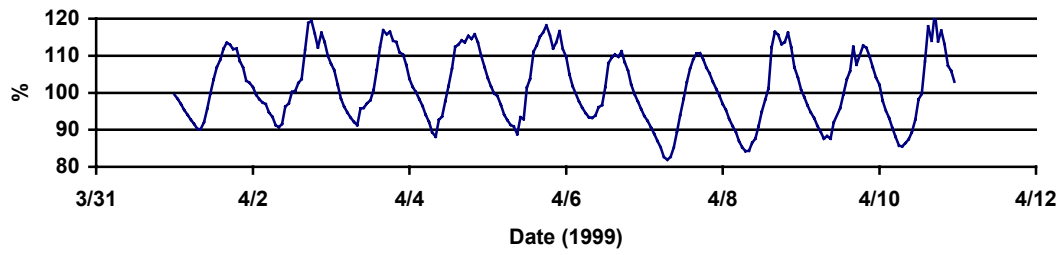
**EXHIBIT 4-5**

Daily Pattern of DO at PSTA Test Cell 3  
*PSTA Research Plan*



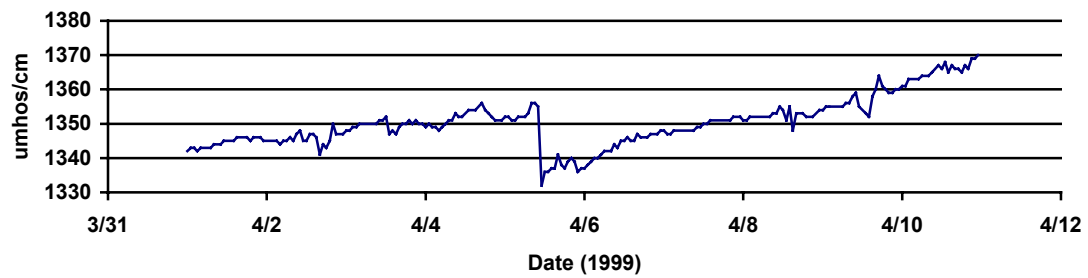
**EXHIBIT 4-6**

Daily Pattern of Percent DO Saturation at PSTA Test Cell 3  
*PSTA Research Plan*



**EXHIBIT 4-7**

Daily pattern of Conductivity at PSTA Test Cell 3  
*PSTA Research Plan*





**Exhibit 4-8**
**Summary of ENR PSTA Test Cell Sampling Plan**

Parameter	Sampling Period (years)	Sample Frequency					Number of Samples		
		Combined Inflow	Inflow	Sample Frequency		Outflow	Field	QC	Total
				1/3	2/3				
Field Sampling									
Flow	1.0	C(I)	W	NS	NS	W	312	0	312
Water temperature	1.0	C(I)	W	M	M	W	384	0	384
Dissolved oxygen	1.0	C(I)	W	M	M	W	384	0	384
pH	1.0	C(I)	W	M	M	W	384	0	384
Conductivity	1.0	C(I)	W	M	M	W	384	0	384
PAR	1.0	NS	NS	M	M	NS	0	0	0
Water Quality Analyses									
Phosphorus (P) Series									
Total P	1.0	W(D)	M	Q	Q	W	216	43	259
Dissolved Reactive P	1.0	W(D)	M	Q	Q	W	216	43	259
Total Dissolved P	1.0	W(D)	M	Q	Q	W	216	43	259
Nitrogen (N) Series									
Total N	1.0	M	Q	Q	Q	M	84	17	101
Ammonia N	1.0	M	Q	Q	Q	M	84	17	101
Total kjeldahl N	1.0	M	Q	Q	Q	M	84	17	101
Nitrate+nitrite N	1.0	M	Q	Q	Q	M	84	17	101
Total organic carbon	1.0	M	Q	Q	Q	M	84	17	101
Total suspended solids	1.0	M	Q	Q	Q	M	84	17	101
Calcium	1.0	M	Q	Q	Q	M	84	17	101
Alkalinity	1.0	M	Q	Q	Q	M	84	17	101
Biological Analyses									
Periphyton Cover	1.0	NS	M	M	M	M	144	0	144
Periphyton Dominant Species	1.0	NS	NS	M	M	NS	72	0	72
Biomass (AFDW)	1.0	NS	NS	M	M	NS	72	14	86
Calcium	1.0	NS	NS	M	M	NS	72	14	86
Cholorophyll a, b, c, phaeophytin	1.0	NS	NS	M	M	NS	72	14	86
Phosphorus (P) Series									
Total P	1.0	NS	NS	M	M	NS	72	14	86
Total Inorganic P	1.0	NS	NS	M	M	NS	72	14	86
Non-reactive P	1.0	NS	NS	Q	Q	NS	12	2	14
Total kjeldahl N	1.0	NS	NS	Q	Q	NS	24	5	29
Sediments									
Phosphorus (P) Series									
Total P	1.0	NS	NS	M	M	NS	72	14	86
Total Inorganic P	1.0	NS	NS	M	M	NS	72	14	86
Non-reactive P	1.0	NS	NS	Q	Q	NS	12	2	14
Phosphorus Sorption/Desorption	1.0	NS			A		3	0	3
Total kjeldahl N	1.0	NS	NS	Q	Q	NS	24	5	29
Total organic carbon	1.0	NS	NS	Q	Q	NS	24	5	29
Bulk density	1.0	NS	NS	M	M	NS	72	14	86
Solids (percent)	1.0	NS	NS	M	M	NS	72	14	86
Accretion	1.0	NS	NS	A	A	NS	6	0	6
System-Level Parameters									
Gross primary productivity	1.0	NS			Q		12	0	12
Net primary productivity	1.0	NS			Q		12	0	12
Community respiration	1.0	NS			Q		12	0	12
Totals							4173	413	4586

**Notes:**

mesocosms = 3  
Assumes sampling period (years) = 1  
W = weekly  
M = monthly  
Q = quarterly  
A = annually  
(D) = sampled by District  
C(I) = continuous with instrument  
NS = not sampled

**EXHIBIT 4-9**

Summary of Phosphorus data from the PSTA Test Cells for the Period from February 23, 1999 to April 30, 1999.

PSTA Research Project

			Test Cell											
			3				8				13			
Parameter		Head Cell	Inflow	stn 1/3	stn 2/3	Outflow	Inflow	stn 1/3	stn 2/3	Outflow	Inflow	stn 1/3	stn 2/3	Outflow
TP (mg/L)	Avg	0.024	0.027	0.026	0.023	0.038	0.028	0.020	0.023	0.030	0.028	0.033	0.032	0.043
	Max	0.032	0.029	0.026	0.023	0.078	0.028	0.020	0.023	0.057	0.030	0.033	0.032	0.086
	Min	0.017	0.025	0.026	0.023	0.013	0.028	0.020	0.023	0.012	0.026	0.033	0.032	0.027
	Std Dev	0.006	0.003	---	---	0.018	0.000	---	---	0.013	0.003	---	---	0.018
	n	5	3	1	1	10	3	1	1	10	3	1	1	10
TDP (mg/L)	Avg	0.012	0.016	0.012	0.018	0.014	0.014	0.010	0.010	0.015	0.014	0.011	0.010	0.014
	Max	0.017	0.021	0.012	0.018	0.025	0.017	0.010	0.010	0.025	0.017	0.011	0.010	0.018
	Min	0.009	0.010	0.012	0.018	0.009	0.010	0.010	0.010	0.008	0.010	0.011	0.010	0.008
	Std Dev	0.004	0.008	---	---	0.005	0.005	---	---	0.006	0.005	---	---	0.004
	n	5	3	1	1	10	3	1	1	10	3	1	1	10
SRP (mg/L)	Avg	0.005	0.006	0.004	0.005	0.003	0.004	0.010	0.007	0.005	0.005	0.010	0.010	0.005
	Max	0.009	0.008	0.004	0.005	0.005	0.005	0.010	0.007	0.016	0.006	0.010	0.010	0.010
	Min	0.003	0.003	0.004	0.005	0.002	0.003	0.010	0.007	0.002	0.003	0.010	0.010	0.003
	Std Dev	0.003	0.004	---	---	0.001	0.001	---	---	0.005	0.002	---	---	0.002
	n	5	3	1	1	10	3	1	1	10	3	1	1	10
TPP (mg/L)	Avg	0.012	0.012	0.014	0.005	0.025	0.015	0.010	0.013	0.014	0.015	0.022	0.022	0.029
	Max	0.016	0.015	0.014	0.005	0.069	0.018	0.010	0.013	0.046	0.016	0.022	0.022	0.070
	Min	0.006	0.008	0.014	0.005	-0.001	0.011	0.010	0.013	0.000	0.013	0.022	0.022	0.009
	Std Dev	0.005	0.005	---	---	0.019	0.005	---	---	0.013	0.002	---	---	0.019
	n	5	3	1	1	10	3	1	1	10	3	1	1	10
DOP (mg/L)	Avg	0.007	0.010	0.008	0.013	0.011	0.010	0.000	0.003	0.011	0.009	0.001	0.000	0.009
	Max	0.014	0.018	0.008	0.013	0.020	0.014	0.000	0.003	0.022	0.014	0.001	0.000	0.015
	Min	0.001	0.002	0.008	0.013	0.006	0.005	0.000	0.003	0.001	0.004	0.001	0.000	0.002
	Std Dev	0.005	0.011	---	---	0.005	0.006	---	---	0.006	0.007	---	---	0.004
	n	5	3	1	1	10	3	1	1	10	3	1	1	10
Date	Min	02/23/1999	02/24/1999	03/29/1999	03/29/1999	02/23/1999	02/24/1999	03/29/1999	03/29/1999	02/23/1999	02/24/1999	03/29/1999	03/29/1999	02/23/1999
	Max	04/12/1999	04/12/1999	03/29/1999	03/29/1999	04/27/1999	04/12/1999	03/29/1999	03/29/1999	04/27/1999	04/12/1999	03/29/1999	03/29/1999	04/27/1999

**EXHIBIT 4-10**

Summary of Nitrogen data from the PSTA Test Cells for the Period from February 23, 1999 to April 30, 1999

PSTA Research Project

Parameter		Head Cell	Test Cell											
			3				8				13			
			Inflow	stn 1/3	stn 2/3	Outflow	Inflow	stn 1/3	stn 2/3	Outflow	Inflow	stn 1/3	stn 2/3	Outflow
TN (mg/L)	Avg	1.492	1.750	0.610	1.060	1.206	1.553	1.810	2.010	0.900	2.040	0.610	1.410	1.213
	Max	2.298	2.220	0.610	1.060	1.520	2.250	1.810	2.010	1.100	2.270	0.610	1.410	1.740
	Min	0.328	1.280	0.610	1.060	0.668	0.856	1.810	2.010	0.618	1.810	0.610	1.410	0.629
	Std Dev	0.848	0.665	---	---	0.468	0.986	---	---	0.251	0.325	---	---	0.558
	n	4	2	1	1	3	2	1	1	3	2	1	1	3
TKN (mg/L)	Avg	1.419	1.625	0.610	1.060	1.207	1.410	1.810	2.010	0.900	1.900	0.610	1.410	1.187
	Max	2.200	2.100	0.610	1.060	1.520	2.100	1.810	2.010	1.100	2.100	0.610	1.410	1.660
	Min	0.247	1.150	0.610	1.060	0.670	0.720	1.810	2.010	0.618	1.700	0.610	1.410	0.630
	Std Dev	0.838	0.672	---	---	0.467	0.976	---	---	0.251	0.283	---	---	0.520
	n	4	2	1	1	3	2	1	1	3	2	1	1	3
ORG N (mg/L)	Avg	1.308	1.535	0.590	1.040	1.187	1.325	1.790	1.990	0.880	1.820	0.590	1.390	1.167
	Max	2.010	1.940	0.590	1.040	1.500	1.950	1.790	1.990	1.080	1.960	0.590	1.390	1.640
	Min	0.157	1.130	0.590	1.040	0.650	0.700	1.790	1.990	0.598	1.680	0.590	1.390	0.610
	Std Dev	0.803	0.573	---	---	0.467	0.884	---	---	0.251	0.198	---	---	0.520
	n	4	2	1	1	3	2	1	1	3	2	1	1	3
NO2NO3 (mg/L)	Avg	0.079	0.123	0.025	0.025	0.025	0.142	0.025	0.025	0.025	0.139	0.025	0.025	0.043
	Max	0.110	0.125	0.025	0.025	0.025	0.150	0.025	0.025	0.025	0.170	0.025	0.025	0.079
	Min	0.025	0.120	0.025	0.025	0.025	0.134	0.025	0.025	0.025	0.107	0.025	0.025	0.025
	Std Dev	0.038	0.004	---	---	0.000	0.011	---	---	0.000	0.045	---	---	0.031
	n	4	2	1	1	3	2	1	1	3	2	1	1	3
NH3 (mg/L)	Avg	0.112	0.090	0.020	0.020	0.020	0.085	0.020	0.020	0.020	0.080	0.020	0.020	0.020
	Max	0.190	0.160	0.020	0.020	0.020	0.150	0.020	0.020	0.020	0.140	0.020	0.020	0.020
	Min	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020
	Std Dev	0.073	0.099	---	---	0.000	0.092	---	---	0.000	0.085	---	---	0.000
	n	4	2	1	1	3	2	1	1	3	2	1	1	3
Date	Min	02/23/1999	02/24/1999	03/31/1999	03/31/1999	02/23/1999	02/24/1999	03/31/1999	03/31/1999	02/23/1999	02/24/1999	03/31/1999	03/31/1999	02/23/1999
	Max	04/12/1999	03/31/1999	03/31/1999	03/31/1999	04/12/1999	03/31/1999	03/31/1999	03/31/1999	04/12/1999	03/31/1999	03/31/1999	03/31/1999	04/12/1999

**EXHIBIT 4-11**

Summary of "Other Parameters" from the PSTA Test Cells for the Period from February 23, 1999 to April 30, 1999

PSTA Research Project

		South Test Cells												
		Head	3				8				13			
Parameter		Cell	Inflow	stn 1/3	stn 2/3	Outflow	Inflow	stn 1/3	stn 2/3	Outflow	Inflow	stn 1/3	stn 2/3	Outflow
Alkal (mg/L)	Avg	250	297	274	273	270	296	261	262	262	297	259	253	253
	Max	304	304	274	273	276	302	261	262	276	304	259	253	278
	Min	120	290	274	273	260	290	261	262	247	290	259	253	223
	StdDev	87	10	---	---	9	8	---	---	15	10	---	---	28
	BDL	1	---	---	---	---	---	---	---	---	---	---	---	---
	Count	4	2	1	1	3	2	1	1	3	2	1	1	3
CA (mg/L)	Avg	68.2	70.9	56.8	56.5	66.3	69.3	54.3	52.3	57.0	69.0	49.5	48.8	54.0
	Max	90.1	77.0	56.8	56.5	77.7	76.0	54.3	52.3	72.0	76.0	49.5	48.8	70.9
	Min	48.5	64.8	56.8	56.5	55.2	62.6	54.3	52.3	46.0	62.0	49.5	48.8	41.8
	StdDev	17.2	8.6	---	---	11.3	9.5	---	---	13.5	9.9	---	---	15.1
	Count	4	2	1	1	3	2	1	1	3	2	1	1	3
TOC (mg/L)	Avg	34.1	32.4	34.6	35.0	36.1	33.2	35.7	35.3	36.0	33.0	35.2	35.6	36.6
	Max	40.2	33.7	34.6	35.0	39.9	35.4	35.7	35.3	40.2	35.0	35.2	35.6	41.4
	Min	30.0	31.0	34.6	35.0	33.0	31.0	35.7	35.3	32.5	31.0	35.2	35.6	32.7
	StdDev	4.6	1.9	---	---	3.5	3.1	---	---	3.9	2.8	---	---	4.4
	Count	4	2	1	1	3	2	1	1	3	2	1	1	3
TSS (mg/L)	Avg	8.8	3.3	2.0	2.0	5.7	3.4	2.0	6.0	4.0	3.0	6.0	2.0	6.7
	Max	14.0	4.5	2.0	2.0	12.0	4.7	2.0	6.0	8.0	4.0	6.0	2.0	12.0
	Min	6.0	2.0	2.0	2.0	2.0	2.0	2.0	6.0	2.0	2.0	6.0	2.0	2.0
	StdDev	3.8	1.8	---	---	5.5	1.9	---	---	3.5	1.4	---	---	5.0
	Count	4	2	1	1	3	2	1	1	3	2	1	1	3
	BDL	---	1	1	1	2	1	1	---	2	1	---	1	1
Date	Min	02/23/1999	02/24/1999	03/31/1999	03/31/1999	02/23/1999	02/24/1999	03/31/1999	03/31/1999	02/23/1999	02/24/1999	03/31/1999	03/31/1999	02/23/1999
	Max	04/12/1999	03/31/1999	03/31/1999	03/31/1999	04/12/1999	03/31/1999	03/31/1999	03/31/1999	04/12/1999	03/31/1999	03/31/1999	03/31/1999	04/12/1999

**EXHIBIT 4-12**

Average Values for Biological Analyses Conducted at the ENR PSTA Test Cells, February 23, 1999 to April 30, 1999

*PSTA Research Project*

Parameter	PSTA Test Cells		
	3	8	13
Plant Cover (%)			
Blue Green Algal mat	3	2	4
Emergent Macrophyte	2	2	4
Floating Aquatic Plants	1	1	1
Green Algal mat	2	2	4
Submerged Aquatic Plants	3	2	22
Total	11	9	35
Algal Density (# cells/m <sup>2</sup> ) x 10 <sup>9</sup>	4	5	18
Algal Diversity			
Average (# spp per station)	34	32	18
Total (# spp per test cell)	47	45	27
AFDW Biomass (g/m <sup>2</sup> )	105.1	88.6	1342.4
Calcium (mg/L)	161.7	235.5	962.2
Chlorophyll a corrected (mg/m <sup>2</sup> )	12.8	10.1	49.4
Chlorophyll a (mg/m <sup>2</sup> )	18.7	10.8	64.2
Chlorophyll b (mg/m <sup>2</sup> )	0.8	0.9	19.6
Chlorophyll c (mg/m <sup>2</sup> )	2.5	2.1	36.8
Phaeophytin (mg/m <sup>2</sup> )	9.0	1.1	24.0

Notes:

1. Plant Cover estimates taken on 2/23/99, 3/3/99, 3/29/99, and 4/15/99 and averaged.
2. AFDW (ash free dry weight), calcium, chlorophyll a, b, and c, and phaeophytin from samples collected on 2/23-24/99 and 4/14/99 from each cell at stations 1/3 and 2/3 and averaged.
3. Algal density and diversity, from samples collected 4/14/99 from each cell at stations 1/3 and 2/3.



**EXHIBIT 4-13**  
Photograph of *Eleocharis* sp. with Floating Periphyton/*Utricularia* Mix.  
*PSTA Research Project*





**EXHIBIT 4-14**

Photograph of Filamentous Algal Growth on *Eleocharis* sp. in PSTA Test Cell  
*PSTA Research Project*

**EXHIBIT 4-15**

## PSTA South Test Cell Sediment Analyses Summary

*PSTA Research Project*

Parameter	PSTA Test Cells		
	3	8	13
Solids (%)	68.7	70.5	41.3
Bulk Density (g/cm <sup>3</sup> )	1.3	1.4	0.35
Sediment samples collected on 2/25/99 and 4/14/99 from each cell at stations 1/3 and 2/3.			

**EXHIBIT 4-16**

## Estimated Community Metabolism Summary for the PSTA Test Cells for the Period from February through April 1999

*PSTA Research Project*

Parameter		Test Cell		
		3	8	13
GPP(day)	Avg	1.62	1.68	2.14
	Min	0.39	0.72	0.24
	Max	2.91	4.59	8.59
	n	43	78	22
CR(24hr)	Avg	1.67	1.72	1.85
	Min	0.62	0.41	-0.83
	Max	3.30	4.94	7.43
	n	43	78	22
NPP(24hr)	Avg	-0.05	-0.05	0.30
	Min	-0.96	-2.26	-2.44
	Max	1.22	3.16	1.88
	n	43	78	22

## Notes:

1. All values in grams oxygen per meter squared per day.



## Porta-PSTA Mesocosms

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### Water Regime

The Porta-PSTAs water regime includes the components of water depth fluctuations and water mass balance. Water level measurements in the Porta-PSTAs have been recorded for each of the 24 mesocosms no less than weekly. All water depth records in this report are based on staff gauge readings.

Water inflows to the Porta-PSTAs are estimated based on timed volume measurements at the inlet of each mesocosm. Outflows are estimated using the same method at each mesocosm outlet. Exhibit 5-1 summarizes the average water regime data by Porta-PSTA treatment. Water level, inflow, and outflow trend charts by treatment are provided in Appendix A.

### Field Parameters

Field parameters (water temperature, pH, DO, DO percent saturation, and specific conductance) are measured in the Porta-PSTAs on a weekly basis at the inflow and outflow points, and monthly at one internal station of each Porta-PSTA, as shown in Exhibit 5-2. In addition, one recording data sonde unit is installed in the Head Tank to continuously document inflow conditions. This section summarizes the results from these field parameter measurements.

Two recording data sonde units are routinely rotated between these mesocosms every 3 to 4 days to provide diel monthly records for each test cell each month. For April 1999, only a portion of the month was included in the experimental operations of the Porta-PSTAs; therefore, diel coverage of each mesocosm was not accomplished this month.

Exhibit 5-3 summarizes the field parameter data available for each treatment following mesocosm stabilization of inflow and depth conditions during this quarter. Example time-series plots of hourly data averaged from the Treatment 3 mesocosms are provided for April 1999 in Exhibits 5-4 through 5-8 for temperature, pH, DO, DO percent saturation, and conductivity, respectively. Detailed trend plots of hourly field parameter data for the third quarter can be observed in Appendix B. Diurnal fluctuations of DO and pH are a reflection of aquatic primary productivity in the cells (see Community Metabolism section of this report). No marked diurnal pattern was observed for specific conductance during this period of operation.

### Laboratory Analyses

Exhibit 5-9 summarizes the water quality sampling schedule and parameter list for the Porta-PSTA mesocosms. Comments regarding some key parameters are provided below.

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## Phosphorus

Head Tank samples, representative of the inflow water quality, and mesocosm outflow samples are collected on a weekly basis for analysis of total phosphorus (TP), total dissolved phosphorus (TDP), and dissolved reactive phosphorus (DRP). Individual cell inflows are monitored monthly and the internal station is sampled quarterly. Total particulate phosphorus (TPP) is estimated in these samples by difference (TP-TDP) as is dissolved organic phosphorus (DOP) which is equal to (TDP-DRP). Exhibit 5-10 summarizes phosphorus data from the Porta-PSTAs during the April 1999 monitoring period.

## Nitrogen

In April, total nitrogen and major component nitrogen forms were analyzed in samples collected at the Head Tank and at the outflows of the 24 Porta-PSTAs. The nitrogen data available for April 1999 are summarized in Exhibit 5-11.

## Other Water Quality Parameters

The Porta-PSTA mesocosms were also sampled in April 1999 at the Head Tank and at the mesocosm outflow points for total suspended solids (TSS), total organic carbon (TOC), calcium, and alkalinity. Exhibit 5-12 summarizes the results for these parameters during this initial month of Porta-PSTA operations.

## Biological Analyses

Biological analyses being conducted in the Porta-PSTAs include plant cover and water column samples that are subsampled for algal identification and counts, biomass, calcium content, chlorophyll (*a*, *b*, *c*, and *phaeophytin*), phosphorus (total, total inorganic, and detailed fractionation), and total Kjeldahl nitrogen.

Exhibit 5-13 provides a summary of the biological results from the Porta-PSTAs in April 1999. Exhibit 5-14 presents photographs of vegetation growth (periphyton/*Utricularia* sp. mix and *Eleocharis* sp.) in the Porta-PSTA Test Cells.

## Sediments

Pre-existing and newly deposited soils within the Porta PSTA mesocosms were cored and analyzed in April 1999 from the depth increment 0 to 10 cm for percent solids and bulk density. Beginning next quarter, analyses will include total organic carbon, total Kjeldahl nitrogen, and phosphorus (total, total inorganic, and non-reactive fractionation). Exhibit 5-15 summarizes the percent solids and bulk density results as averages for each treatment from the April 1999 sediment sampling from the Porta-PSTA mesocosms.

## Community Metabolism

Community metabolism is being estimated using the diurnal DO rate-of-change method. An estimated oxygen diffusion rate constant of 0.05 g/m<sup>2</sup>/d was used for these preliminary metabolism estimates. This diffusion rate will be measured during future study activities,

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and the preliminary metabolism values presented in this interim progress report will be adjusted during data synthesis for the final report. System parameters that are estimated with this method include:

- Gross primary production (GPP)
- Community respiration (CR)
- Net Primary Production ( $NPP = GPP - CR$ )

Exhibit 5-16 summarizes the community metabolism estimates for the Porta-PSTA Test Cells for the period from February through April 1999.

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## **Exhibits for Section 5**

**EXHIBIT 5-1**

Porta-PSTA Mesocosm Water Regime Summary for the Period from April 12, 1999 to April 30, 1999

*PSTA Research Project*

Parameter	Porta-PSTA Treatments											
	1	2	3	4	5	6	7	8	9	10	11	12
Water Level (m)												
Avg	0.55	0.61	0.31	0.33	0.63	0.48	0.66	0.64	0.59	0.63	0.37	0.31
Min	0.12	0.59	0.29	0.32	0.62	0.28	0.66	0.64	0.59	0.63	0.37	0.31
Max	0.63	0.62	0.33	0.33	0.65	0.63	0.66	0.64	0.59	0.63	0.38	0.31
Std Dev	0.16	0.01	0.02	0.00	0.01	0.16	0.00	0.00	0.00	0.00	0.01	0.00
n	10	10	12	12	12	10	4	4	4	4	4	4
<i>Period of Record: 4/13/99 - 4/30/99</i>												
Inflow (m <sup>3</sup> /d)												
Avg	0.29	0.30	0.28	0.30	0.60	0.23	0.32	0.34	0.37	0.39	0.92	0.96
Min	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.00	0.00	0.00	0.00
Max	0.43	0.72	0.45	0.71	0.81	0.58	0.45	0.46	0.98	2.88	1.44	1.27
Std Dev	0.13	0.15	0.14	0.15	0.25	0.12	0.13	0.10	0.24	0.56	0.34	0.35
n	67	68	70	67	67	84	23	22	26	23	25	27
<i>Period of Record: 4/12/99 - 4/30/99</i>												
Outflow (m <sup>3</sup> /d)												
Avg	0.29	0.31	0.39	0.38	0.69	0.28	0.31	2.88	0.35	0.27	0.71	0.89
Min	0.00	0.20	0.29	0.35	0.63	0.20	0.29	2.88	0.35	0.27	0.69	0.86
Max	0.56	0.43	0.55	0.43	0.72	0.40	0.32	2.88	0.35	0.27	0.72	0.92
Std Dev	0.24	0.08	0.11	0.03	0.03	0.07	0.02	0.00	0.00	0.00	0.01	0.03
n	9	9	9	9	9	9	3	1	3	3	3	3
<i>Period of Record: 4/19/99</i>												
HLR (cm/d)												
Avg	4.8	5.1	4.6	5.0	10.0	3.8	5.3	5.6	6.2	6.6	5.1	5.3
Min	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.1	0.0	0.0	0.0	0.0
Max	7.2	12.0	7.4	11.8	13.6	9.6	7.4	7.7	16.3	48.0	8.0	7.0
Std Dev	2.1	2.5	2.3	2.5	4.1	1.9	2.1	1.6	4.1	9.3	1.9	1.9
n	67	68	70	67	67	84	23	22	26	23	25	27
<i>Period of Record: 4/12/99 - 4/30/99</i>												



**EXHIBIT 5-2**

Photograph of Porta-PSTA Cell 10 with data sonde located at the internal station  
*PSTA Research Project*

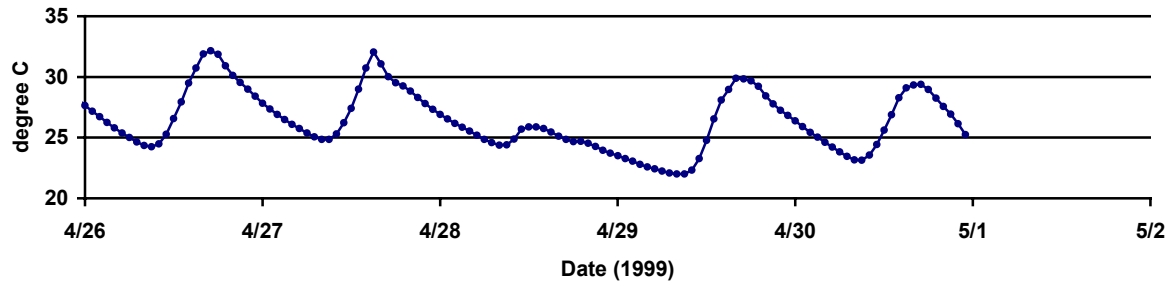
**EXHIBIT 5-3**  
Porta-PSTA Treatment Field Parameter Summary  
PSTA Research Project

Parameter		HT	1	2	3	4	5	6	7	8	9	10	11	12
Water Temperature (C)	Avg	22.5	26.0	21.2	26.8	21.2	27.3	26.0	26.2	26.5	22.6	21.3	24.5	28.1
	Min	5.1	18.3	12.2	21.9	11.0	20.1	16.8	23.5	23.7	15.8	13.1	26.1	26.7
	Max	38.8	32.8	30.2	33.3	32.3	32.2	33.3	28.5	28.6	31.0	29.5	30.6	31.0
	Std Dev	3.6	3.0	3.5	2.7	4.1	2.2	2.9	1.8	1.8	2.9	3.1	1.9	1.8
	n	4140	390	1838	330	970	267	513	8	8	922	1435	8	8
pH (units)	Avg	7.6	8.2	8.1	8.2	8.6	8.2	8.5	8.2	8.1	8.2	8.2	8.2	8.0
	Min	7.2	8.1	6.4	7.6	8.3	7.9	7.9	7.9	8.0	7.9	7.9	7.9	7.8
	Max	8.1	8.5	8.8	8.5	9.0	8.8	9.0	8.4	8.3	8.5	8.5	8.3	8.3
	Std Dev	0.2	0.1	0.2	0.2	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.2	0.2
	n	2005	220	909	127	217	167	267	8	8	922	1435	8	8
Conductivity (µmhos/cm)	Avg	1357	1250	1398	1070	1192	1222	1317	1345	1151	1607	1524	1154	1130
	Min	152	946	41	942	1070	998	1037	1133	1075	1245	1245	1033	1003
	Max	2288	1545	2019	1312	1289	1387	1422	1568	1207	2255	2039	1260	1318
	Std Dev	364	131	166	82	30	81	59	154	47	275	230	68	97
	n	2005	220	909	127	217	167	267	8	8	922	1435	8	8
Dissolved Oxygen Saturation (%)	Avg	55.2	89.5	80.7	89.6	123.6	93.3	119.4	---	---	83.2	89.0	---	---
	Min	19.0	61.3	0.3	59.4	84.7	68.9	88.2	---	---	59.1	37.0	---	---
	Max	83.4	120.2	160.1	137.1	166.9	132.7	165.8	---	---	143.6	136.7	---	---
	Std Dev	14.1	17.8	30.3	21.9	20.7	20.1	17.9	---	---	18.6	17.1	---	---
	n	2001	202	746	103	193	143	245	---	---	914	1427	---	---
Dissolved Oxygen (mg/L)	Avg	4.8	7.0	7.3	7.3	10.0	7.5	9.7	7.4	7.1	7.2	7.8	7.8	7.1
	Min	1.7	5.2	0.0	5.1	7.7	5.7	7.6	6.6	6.3	5.4	3.4	6.8	5.9
	Max	7.4	9.5	12.6	10.0	12.3	12.4	12.6	8.5	8.3	11.8	11.1	9.1	9.0
	Std Dev	1.2	1.3	2.4	1.4	1.2	1.7	1.2	0.6	0.6	1.5	1.2	0.8	1.2
	n	2005	220	909	127	217	167	267	8	8	922	1435	8	8
Period of Record (1999)		2/1	4/13	2/1	4/13	2/1	4/9	4/9	4/13	4/13	3/1	2/1	4/13	4/13
		4/30	4/30	4/22	4/30	4/26	4/26	4/30	4/27	4/27	4/27	4/9	4/27	4/27

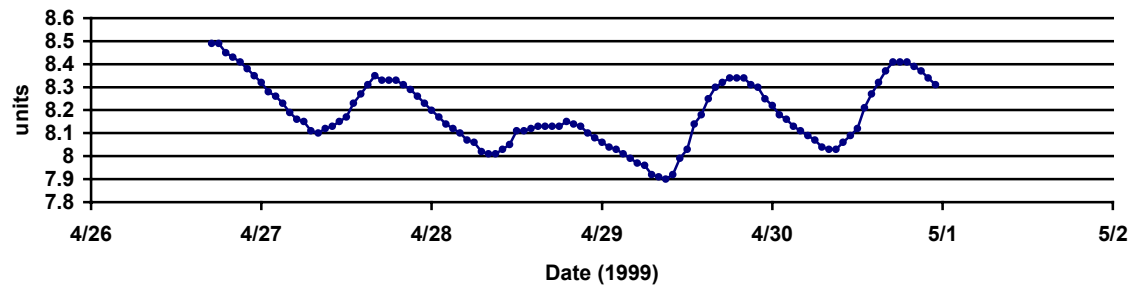
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**EXHIBIT 5-4**

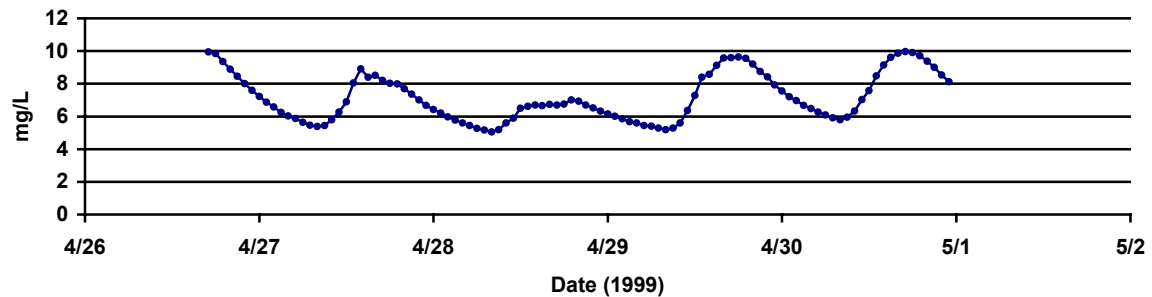
Daily Pattern of Temperature at the Porta-PSTA Treatment 3 Mesocosms  
*PSTA Research Project*

**EXHIBIT 5-5**

Daily Pattern of pH at the Porta-PSTA Treatment 3 Mesocosms  
*PSTA Research Project*

**EXHIBIT 5-6**

Daily Pattern of DO at the Porta-PSTA Treatment 3 Mesocosms  
*PSTA Research Project*



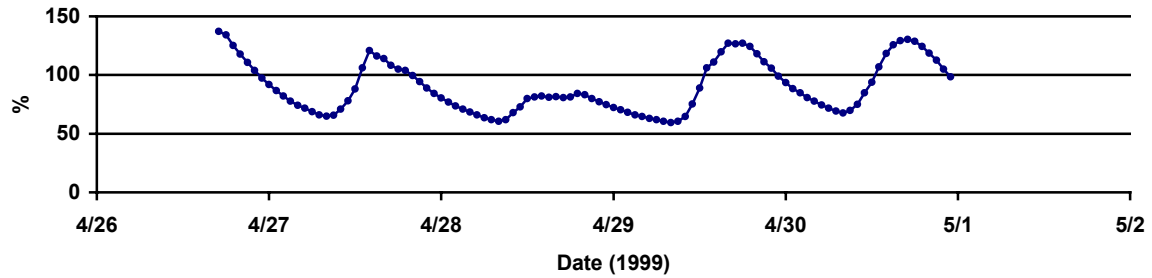


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**EXHIBIT 5-7**

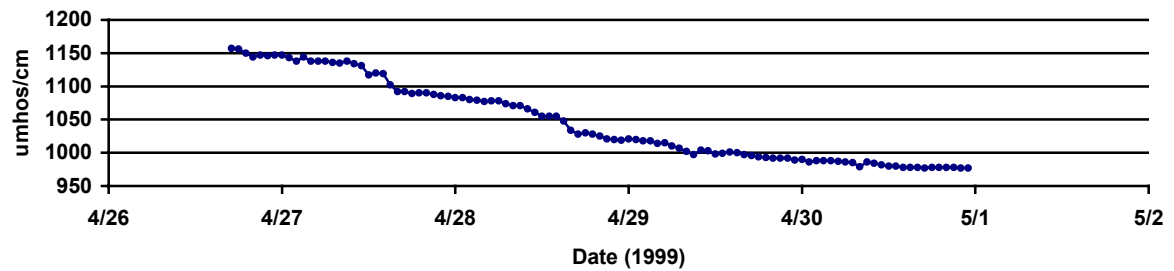
Daily Pattern of Percent DO Saturation at the Porta-PSTA Treatment 3 Mesocosms

*PSTA Research Project*

**EXHIBIT 5-8**

Daily Pattern of Conductivity at the Porta-PSTA Treatment 3 Mesocosms

*PSTA Research Project*



**Exhibit 5-9**
**Summary of Porta-PSTA Sampling Project**

Parameter	Sampling Period (years)	Sample Frequency				Number of Samples		
		Combine d Inflow	Inflow	1/2	Outflow	Field	QC	Total
Field Sampling								
Flow	1.0	NS	C(I)	NS	W	1248	0	1248
Water temperature	1.0	C(I)	W	M	W	2784	0	2784
Dissolved oxygen	1.0	C(I)	W	M	W	2784	0	2784
pH	1.0	C(I)	W	M	W	2784	0	2784
Conductivity	1.0	C(I)	W	M	W	2784	0	2784
PAR	1.0	NS	NS	M	NS	288	0	288
Water Quality Analyses								
Phosphorus (P) Series								
Total P	1.0	W	M	Q	W	1684	337	2021
Dissolved Reactive P	1.0	W	M	Q	W	1684	337	2021
Total Dissolved P	1.0	W	M	Q	W	1684	337	2021
Nitrogen (N) Series								
Total N	1.0	M	Q	Q	M	492	98	590
Ammonia N	1.0	M	Q	Q	M	492	98	590
Total kjeldahl N	1.0	M	Q	Q	M	492	98	590
Nitrate+nitrite N	1.0	M	Q	Q	M	492	98	590
Total organic carbon	1.0	M	Q	Q	M	492	98	590
Total suspended solids	1.0	M	Q	Q	M	492	98	590
Calcium	1.0	M	Q	Q	M	492	98	590
Alkalinity	1.0	M	Q	Q	M	492	98	590
Biological Analyses								
Periphyton Cover	1.0	NS	M	M	M	864	0	864
Macrophyte Stem Count	1.0	NS	NS	M	NS	288	0	288
Periphyton Dominant Species	1.0	NS	NS	M	NS	288	0	288
Biomass (AFDW)	1.0	NS	NS	M	NS	288	58	346
Calcium	1.0	NS	NS	M	NS	288	58	346
Cholorophyll a, b,c, phaeophytin	1.0	NS	NS	M	NS	288	58	346
Phosphorus (P) Series								
Total P	1.0	NS	NS	M	NS	288	58	346
Total Inorganic P	1.0	NS	NS	M	NS	288	58	346
Non-reactive P	1.0	NS	NS	Q	NS	48	10	58
Total kjeldahl N	1.0	NS	NS	Q	NS	96	19	115
Sediments								
Phosphorus (P) Series								
Total P	1.0	NS	NS	M	NS	288	58	346
Total Inorganic P	1.0	NS	NS	M	NS	288	58	346
Non-reactive P	1.0	NS	NS	Q	NS	48	10	58
Phosphorus Sorption/Desorption	1.0	NS	A			24	0	24
Total kjeldahl N	1.0	NS		Q	NS	96	19	115
Total organic carbon	1.0	NS	NS	Q	NS	96	19	115
Bulk density	1.0	NS	NS	M	NS	288	58	346
Solids (percent)	1.0	NS	NS	M	NS	288	58	346
Accretion	1.0	NS	NS	A	NS	24	0	24
System-Level Parameters								
Gross primary productivity	1.0	NS		Q		96	0	96
Net primary productivity	1.0	NS		Q		96	0	96
Community respiration	1.0	NS		Q		96	0	96
Totals						26412	2393	28805

**Notes:**

Assumes number of mesocosms = 24  
 Assumes sampling period (years) = 1  
 W = weekly  
 M = monthly  
 Q = quarterly  
 A = annually  
 (D) = sampled by District  
 C(I) = continuous with instrument  
 NS = not sampled

**Exhibit 5-10**

Summary of Phosphorus from the Porta-PSTA Test Cells for the Period from April 13 to April 27, 1999

PSTA Research Project

			PORTA-PSTA TREATMENTS											
Parameter		Head Tank	1		2		3		4		5		6	
			Inflow	Outflow	Inflow	Outflow	Inflow	Outflow	Inflow	Outflow	Inflow	Outflow	Inflow	Outflow
TP (mg/L)	Avg	0.037	0.028	0.040	0.053	0.039	0.028	0.027	0.032	0.038	0.031	0.033	0.029	0.038
	Max	0.043	0.028	0.066	0.053	0.042	0.032	0.034	0.032	0.051	0.031	0.036	0.029	0.048
	Min	0.027	0.028	0.026	0.053	0.035	0.024	0.020	0.032	0.029	0.031	0.030	0.029	0.028
	Std Dev	0.009	---	0.023	---	0.004	0.005	0.006	---	0.011	---	0.003	---	0.010
	n	3	1	3	1	3	2	4	1	3	1	3	1	3
TDP (mg/L)	Avg	0.019	0.020	0.015	0.019	0.014	0.019	0.016	0.019	0.013	0.019	0.016	0.020	0.013
	Max	0.021	0.020	0.017	0.019	0.015	0.021	0.018	0.019	0.014	0.019	0.017	0.020	0.014
	Min	0.017	0.020	0.013	0.019	0.013	0.018	0.014	0.019	0.013	0.019	0.015	0.020	0.011
	Std Dev	0.002	---	0.002	---	0.001	0.002	0.002	---	0.000	---	0.001	---	0.001
	n	3	1	3	1	3	2	4	1	3	1	3	1	3
SRP (mg/L)	Avg	0.005	0.005	0.004	0.004	0.005	0.005	0.003	0.005	0.003	0.004	0.003	0.004	0.003
	Max	0.006	0.005	0.008	0.004	0.008	0.005	0.005	0.005	0.005	0.004	0.005	0.004	0.004
	Min	0.004	0.005	0.002	0.004	0.003	0.005	0.002	0.005	0.002	0.004	0.002	0.004	0.002
	Std Dev	0.001	---	0.003	---	0.003	0.000	0.002	---	0.002	---	0.002	---	0.001
	n	3	1	3	1	3	2	4	1	3	1	3	1	3
TPP (mg/L)	Avg	0.018	0.009	0.025	0.035	0.025	0.009	0.012	0.013	0.025	0.012	0.017	0.009	0.025
	Max	0.022	0.009	0.053	0.035	0.028	0.011	0.019	0.013	0.038	0.012	0.021	0.009	0.038
	Min	0.010	0.009	0.010	0.035	0.020	0.006	0.004	0.013	0.016	0.012	0.013	0.009	0.015
	Std Dev	0.007	---	0.024	---	0.004	0.004	0.006	---	0.011	---	0.004	---	0.011
	n	3	1	3	1	3	2	4	1	3	1	3	1	3
DOP (mg/L)	Avg	0.014	0.015	0.011	0.015	0.009	0.015	0.013	0.015	0.010	0.015	0.013	0.016	0.010
	Max	0.016	0.015	0.014	0.015	0.012	0.016	0.016	0.015	0.012	0.015	0.015	0.016	0.011
	Min	0.013	0.015	0.008	0.015	0.006	0.013	0.008	0.015	0.008	0.015	0.010	0.016	0.009
	Std Dev	0.002	---	0.003	---	0.003	0.002	0.003	---	0.002	---	0.003	---	0.001
	n	3	1	3	1	3	2	4	1	3	1	3	1	3
DATE	04/13/1999		04/26/1999	04/13/1999	04/26/1999	04/13/1999	04/26/1999	04/13/1999	04/26/1999	04/13/1999	04/26/1999	04/13/1999	04/26/1999	04/13/1999
	04/27/1999		04/26/1999	04/26/1999	04/26/1999	04/26/1999	04/27/1999	04/27/1999	04/26/1999	04/26/1999	04/26/1999	04/26/1999	04/26/1999	04/26/1999

**Exhibit 5-10**

Summary of Phosphorus from the Porta-PS

PSTA Research Project

			PORTA-PSTA TREATMENTS											
		Head	7		8		9		10		11		12	
Parameter		Tank	Inflow	Outflow	Inflow	Outflow	Inflow	Outflow	Inflow	Outflow	Inflow	Outflow	Inflow	Outflow
TP (mg/L)	Avg	0.037	0.035	0.062	0.026	0.047	0.037	0.031	0.024	0.027	0.036	0.063	0.025	0.037
	Max	0.043	0.035	0.130	0.026	0.088	0.037	0.035	0.024	0.034	0.036	0.070	0.025	0.045
	Min	0.027	0.035	0.026	0.026	0.022	0.037	0.027	0.024	0.024	0.036	0.055	0.025	0.026
	Std Dev	0.009	---	0.059	---	0.036	---	0.004	---	0.006	---	0.008	---	0.010
	n	3	1	3	1	3	1	3	1	3	1	3	1	3
TDP (mg/L)	Avg	0.019	0.019	0.018	0.019	0.016	0.019	0.016	0.018	0.015	0.019	0.018	0.018	0.015
	Max	0.021	0.019	0.021	0.019	0.018	0.019	0.018	0.018	0.018	0.019	0.019	0.018	0.016
	Min	0.017	0.019	0.014	0.019	0.014	0.019	0.014	0.018	0.012	0.019	0.016	0.018	0.014
	Std Dev	0.002	---	0.004	---	0.002	---	0.002	---	0.003	---	0.002	---	0.001
	n	3	1	3	1	3	1	3	1	3	1	3	1	3
SRP (mg/L)	Avg	0.005	0.004	0.005	0.004	0.003	0.006	0.004	0.005	0.005	0.006	0.003	0.005	0.003
	Max	0.006	0.004	0.006	0.004	0.005	0.006	0.006	0.005	0.007	0.006	0.005	0.005	0.004
	Min	0.004	0.004	0.003	0.004	0.001	0.006	0.002	0.005	0.002	0.006	0.002	0.005	0.003
	Std Dev	0.001	---	0.002	---	0.002	---	0.002	---	0.003	---	0.002	---	0.001
	n	3	1	3	1	3	1	3	1	3	1	3	1	3
TPP (mg/L)	Avg	0.018	0.016	0.044	0.007	0.031	0.018	0.014	0.006	0.013	0.017	0.045	0.007	0.022
	Max	0.022	0.016	0.109	0.007	0.070	0.018	0.018	0.006	0.022	0.017	0.052	0.007	0.029
	Min	0.010	0.016	0.012	0.007	0.008	0.018	0.009	0.006	0.006	0.017	0.039	0.007	0.012
	Std Dev	0.007	---	0.056	---	0.034	---	0.005	---	0.008	---	0.007	---	0.009
	n	3	1	3	1	3	1	3	1	3	1	3	1	3
DOP (mg/L)	Avg	0.014	0.015	0.013	0.015	0.013	0.013	0.013	0.013	0.010	0.013	0.014	0.013	0.012
	Max	0.016	0.015	0.015	0.015	0.017	0.013	0.015	0.013	0.013	0.013	0.017	0.013	0.013
	Min	0.013	0.015	0.009	0.015	0.009	0.013	0.008	0.013	0.007	0.013	0.011	0.013	0.010
	Std Dev	0.002	---	0.003	---	0.004	---	0.004	---	0.003	---	0.003	---	0.002
	n	3	1	3	1	3	1	3	1	3	1	3	1	3
DATE	04/13/1999		04/27/1999	04/13/1999	04/27/1999	04/13/1999	04/27/1999	04/13/1999	04/27/1999	04/13/1999	04/27/1999	04/13/1999	04/27/1999	04/13/1999
	04/27/1999		04/27/1999	04/27/1999	04/27/1999	04/27/1999	04/27/1999	04/27/1999	04/27/1999	04/27/1999	04/27/1999	04/27/1999	04/27/1999	04/27/1999

**Exhibit 5-11**

Summary of Nitrogen Analyses from the Porta-PSTA Test Cells for April 26 and 27, 1999

*PSTA Research Project*

Treatment	N_TOT (mg/L)	NH3 (mg/L)	NO2&NO3 (mg/L)	TKN (mg/L)	OrgN (mg/L)
Head Tank	1.48	0.02	0.07	1.41	1.39
1 - Outflow	1.04	0.05	0.03	1.04	1.00
2 - Outflow	0.92	0.02	0.03	0.92	0.90
3 - Outflow	2.17	0.02	0.98	1.20	1.18
4 - Outflow	0.99	0.02	0.05	0.95	0.93
5 - Outflow	0.91	0.02	0.03	0.91	0.89
6 - Outflow	1.43	0.05	0.11	1.33	1.28
7 - Outflow	1.73	0.02	0.18	1.55	1.53
8 - Outflow	1.34	0.02	0.03	1.34	1.32
9 - Outflow	2.06	0.02	0.46	1.60	1.58
10 - Outflow	1.49	0.02	0.03	1.49	1.47
11 - Outflow	1.38	0.02	0.03	1.38	1.36
12 - Outflow	1.59	0.02	0.03	1.59	1.57

Note: Samples collected on 4/26/99 - 4/27/99

**Exhibit 5-12**

Summary of "Other Parameters" from the Porta-PSTA Test Cells for April 26 and 27, 1999

*PSTA Research Project*

		Porta-PSTA Treatments												
Parameter		HC	1 Outflow	2 Outflow	3 Outflow	4 Outflow	5 Outflow	6 Outflow	7 Outflow	8 Outflow	9 Outflow	10 Outflow	11 Outflow	12 Outflow
Alkalinity (mg/L)	Avg	170	199	173	199	156	183	151	209	198	230	206	181	194
	Max	170	210	174	214	162	197	162	209	198	230	206	181	194
	Min	170	188	172	187	152	160	140	209	198	230	206	181	194
	StdDev	---	16	1	14	5	20	16	---	---	---	---	---	---
	Count	1	2	2	3	3	3	2	1	1	1	1	1	1
CA (mg/L)	Avg	38.1	46.1	36.5	44.8	34.1	41.8	32.9	44.0	43.0	52.6	40.4	42.0	49.4
	Max	38.1	48.3	38.5	47.6	35.3	47.3	36.6	44.0	43.0	52.6	40.4	42.0	49.4
	Min	38.1	43.8	34.4	41.5	33.4	33.4	28.7	44.0	43.0	52.6	40.4	42.0	49.4
	StdDev	---	3.2	2.9	3.1	1.0	7.4	4.0	---	---	---	---	---	---
	Count	1	2	2	3	3	3	3	1	1	1	1	1	1
TOC (mg/L)	Avg	23.0	33.5	34.1	32.6	35.1	29.7	37.5	29.6	28.6	30.0	32.7	28.8	29.7
	Max	23.0	35.2	36.2	34.1	36.9	32.4	38.6	29.6	28.6	30.0	32.7	28.8	29.7
	Min	23.0	31.7	31.9	30.3	32.6	27.7	36.5	29.6	28.6	30.0	32.7	28.8	29.7
	StdDev	---	2.5	3.0	2.0	2.2	2.4	1.1	---	---	---	---	---	---
	Count	1	2	2	3	3	3	3	1	1	1	1	1	1
TSS (mg/L)	Avg	2.0	10.0	8.0	5.3	9.0	6.0	4.0	8.0	2.0	18.0	8.0	20.0	24.0
	Max	2.0	14.0	14.0	8.0	16.0	10.0	6.0	8.0	2.0	18.0	8.0	20.0	24.0
	Min	2.0	6.0	2.0	4.0	2.0	2.0	2.0	8.0	2.0	18.0	8.0	20.0	24.0
	StdDev	---	5.7	8.5	2.3	9.9	5.7	2.8	---	---	---	---	---	---
	Count	1	2	2	3	2	2	2	1	1	1	1	1	1
	BDL	1	---	1	---	1	1	1	---	1	---	---	---	---
Date		04/27/1999	04/26/1999	04/26/1999	04/26/1999	04/26/1999	04/26/1999	04/26/1999	04/27/1999	04/27/1999	04/27/1999	04/27/1999	04/27/1999	04/27/1999
		04/27/1999	04/26/1999	04/26/1999	04/27/1999	04/26/1999	04/26/1999	04/26/1999	04/27/1999	04/27/1999	04/27/1999	04/27/1999	04/27/1999	04/27/1999

**EXHIBIT 5-13**

Porta-PSTA Treatment Biological Analyses Summary, April 1999

*PSTA Research Project*

Parameter	Porta-PSTA Treatments											
	1	2	3	4	5	6	7	8	9	10	11	12
Plant Cover (%)												
Blue Green Algal mat	0	0.	1	2	4	2	1	1	0	0	2	0
Emergent Macrophyte	1	1	6	2	1	3	1	1	0	0	3	8
Floating Aquatic Plants	0	0	0	0	0	0	1	0	0	0.	0	0
Green Algal mat	0	0	0	0	0	0	0	0	0	0	0	0
Submerged Aquatic Plants	3	3	5	5	2	2	3	3	0	0	0	18
Total	4	4	12	8	8	7	5	5	0	0	5	25
Algal Density (# cells/m <sup>2</sup> ) x 10 <sup>9</sup>	4.01	10.1	3.34	10.8	11.5	14.1	19.9	10.6	13.5	4.99	4.29	1.93
Algal Diversity												
Average (# spp per station)	29	32	28	25	23	29	31	33	16	26	30	31
Total (# spp per test cell)	47	48	44	43	47	44	31	33	16	26	30	31
AFDW Biomass (g/m <sup>2</sup> )	310.3	20.0	552.6	26.8	22.7	14.9	9.2	12.2	1188.5	22.8	28.7	509.9
Calcium (mg/L)	202.0	142.5	339.7	247.0	142.7	156.4	54.5	58.4	449.0	163.0	285.0	354.0
Chlorophyll a corrected (mg/m <sup>2</sup> )	19.5	17.8	29.5	25.4	25.0	11.0	11.9	10.7	23.7	11.9	16.1	20.8
Chlorophyll a (mg/m <sup>2</sup> )	23.3	15.1	39.4	23.3	23.1	13.2	10.8	13.0	23.0	7.1	10.7	24.8
Chlorophyll b (mg/m <sup>2</sup> )	4.1	0.5	7.0	1.0	1.6	1.0	0.3	4.9	1.9	1.1	2.2	0.4
Chlorophyll c (mg/m <sup>2</sup> )	7.1	5.0	17.3	4.9	4.2	2.7	1.1	9.3	40.6	4.8	27.7	0.2
Phaeophytin (mg/m <sup>2</sup> )	5.7	0.3	17.5	0.2	0.3	5.2	0.3	4.0	0.3	0.3	0.2	5.4

Plant Cover estimates taken on 4/27/99. Samples for the remaining parameters were collected on 4/29/99.



**EXHIBIT 5-14**

Porta-PSTA After Seeding with Periphyton/*Utricularia* Mix, Planting with *Eleocharis*, and Initial Spring Growth  
*PSTA Research Project*



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**EXHIBIT 5-15**

## Porta-PSTA Treatment Sediment Analyses Summary

*PSTA Research Project*

Parameter	Porta-PSTA Treatments											
	1	2	3	4	5	6	7	8	9	10	11	12
Solids (%)	31.5	68.5	27.3	67.0	65.3	77.7	77.0	70.0	24.0	66.0	72.0	27.0
Bulk Density (g/cm <sup>3</sup> )	0.37	1.3	0.32	1.3	1.2	1.5	1.4	1.3	0.26	1.3	1.4	0.31

Sediment samples collected on 4/28/99 from each mesocosm.

**EXHIBIT 5-16**

Estimated Community Metabolism Summary for the Porta-PSTA Mesocosms Monitored in April 1999  
*PSTA Research Project*

Parameter		Porta-PSTA Test Cells											
		1	2	5	6	7	8	9	10	11	12	21	22
GPP(day)	Avg	2.86	2.29	3.90	3.22	0.72	2.64	2.27	3.67	1.11	2.84	0.79	0.68
	Min	1.92	0.64	3.76	3.00	0.21	2.45	1.99	3.31	0.69	1.97	0.23	0.01
	Max	3.44	3.88	4.06	3.51	1.76	2.84	2.45	3.91	1.44	3.50	2.67	1.95
	n	5	5	3	3	22	2	3	3	4	4	34	52
CR(24hr)	Avg	2.50	1.94	3.53	2.87	0.80	2.24	2.45	3.40	1.33	2.92	0.95	0.74
	Min	1.58	0.92	3.08	2.45	0.15	2.05	2.16	3.09	1.13	2.41	0.46	-0.02
	Max	3.26	3.25	3.86	3.09	1.38	2.42	2.63	3.60	1.54	3.44	1.70	2.12
	n	5	5	3	3	22	2	3	3	4	4	34	52
NPP(24hr)	Avg	0.36	0.35	0.37	0.35	-0.08	0.41	-0.18	0.27	-0.21	-0.09	-0.16	-0.07
	Min	0.16	-0.32	-0.10	-0.07	-0.96	0.39	-0.27	0.22	-0.50	-0.50	-0.77	-0.87
	Max	0.77	1.89	0.82	0.69	1.57	0.42	-0.11	0.31	0.16	0.52	1.98	1.91
	n	5	5	3	3	22	2	3	3	4	4	34	52

## Notes:

1. Diel monitoring of all of the Porta-PSTAs will be included in future months. Metabolism values provided above for mesocosms for which measures were available for April 12-30, 1999.
2. All values in grams oxygen per meter squared per day.

## SECTION 6

# References

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Doren, R.F. and R.D. Jones. 1996. "Conceptual Design of Periphyton-Based STAs." Memo of Col. T. Rice, COE dated January 30, 1996.

Kadlec, R.H. 1996. "Algal STAs for Achieving Phase II Everglades Protection." Technology Outline, Letter Report dated October 21, 1996. 9 pp.

Kadlec, R.H. 1998. "STAs Report on the Periphyton STA Idea". Draft Memorandum to the US Department of Interior dated December 4, 1998. 7pp.

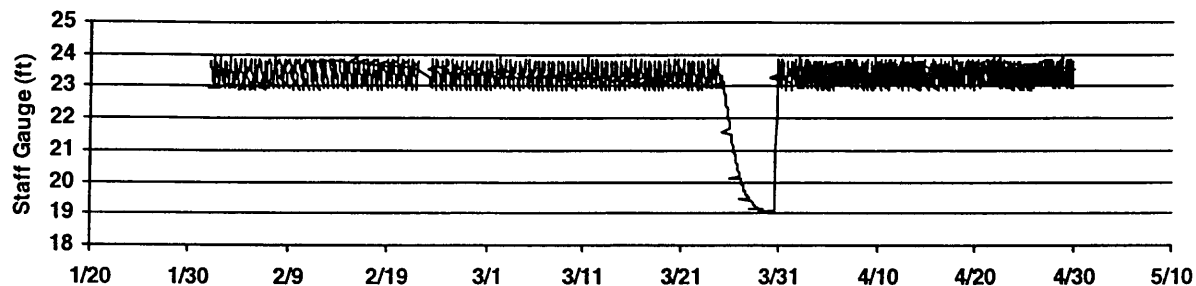
Kadlec, R.H. and W.W. Walker. 1996. "Perspectives on the Periphyton STA Idea". Draft Letter Report dated December 26, 1996. 26pp.

**PSTA South Test Cells and Porta-PSTA  
Treatments  
Water Level, Inflow, and Outflow Trend Charts**

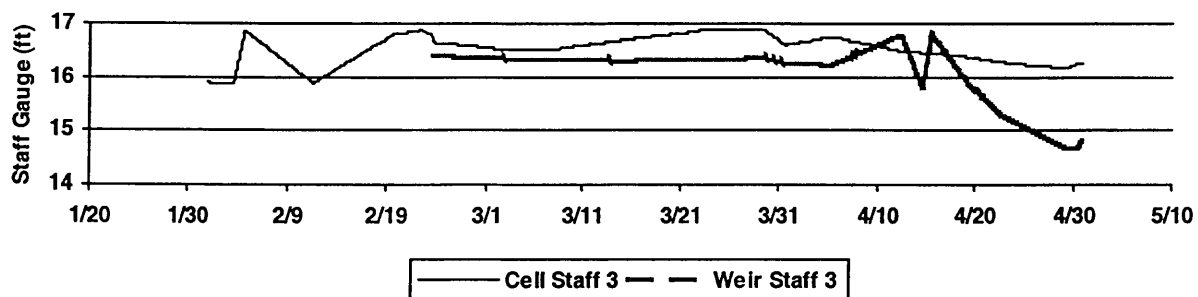
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SFWMD PSTA Research Project  
South Test Cell Stage Summary

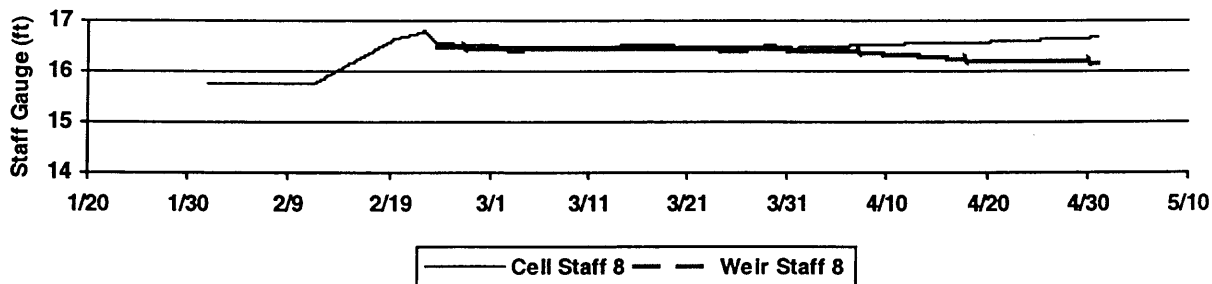
Hourly Stage for Head Cell



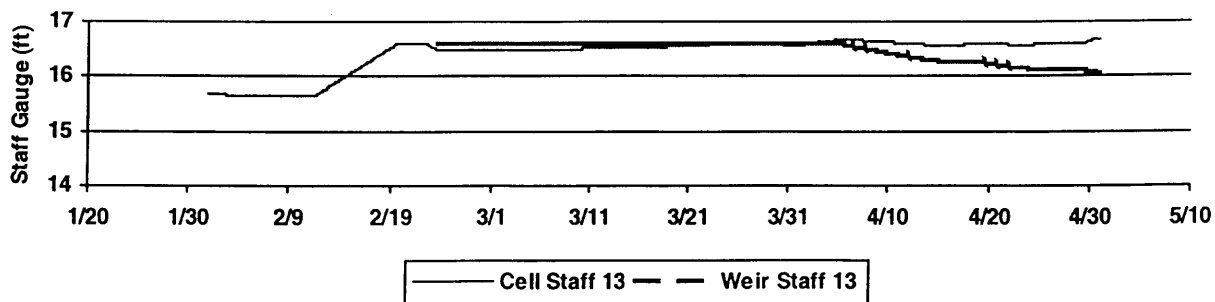
STC Hourly Stage Estimates for Cell 3



STC Hourly Stage Estimates for Cell 8



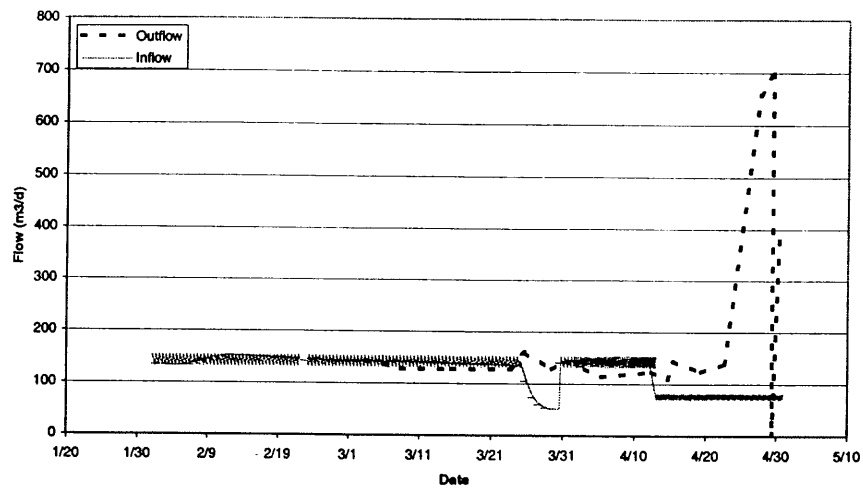
STC Hourly Stage Estimates for Cell 13



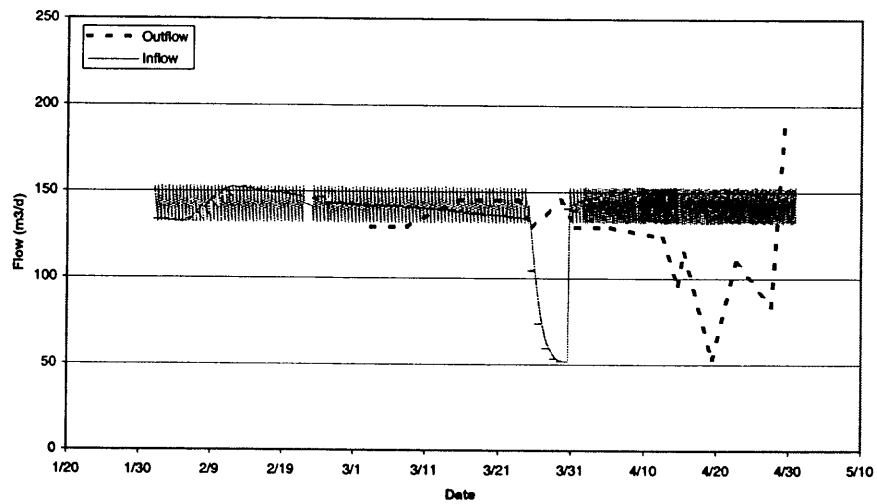
Note: Cell 3, 8, and 13 are estimated hourly staff gauge data calculated from intermittent staff readings

# SFWMD PSTA Research Project PSTA Flow Summary

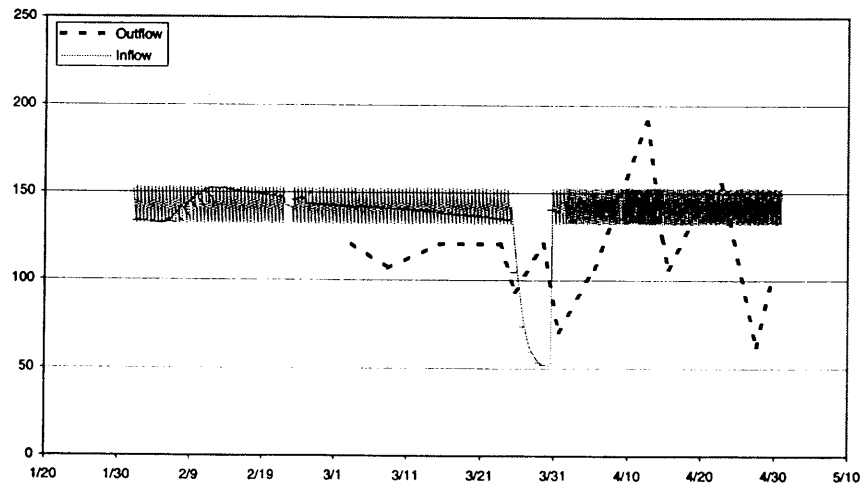
PSTA Test Cell 3



PSTA Test Cell 8

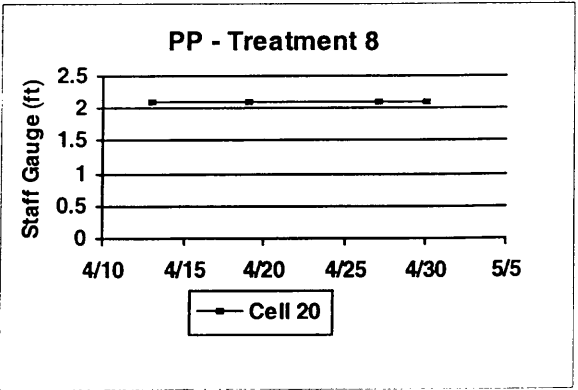
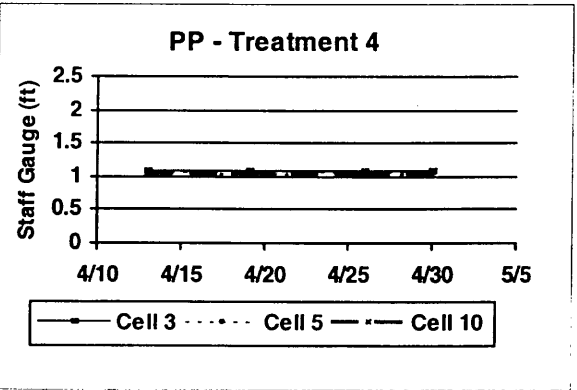
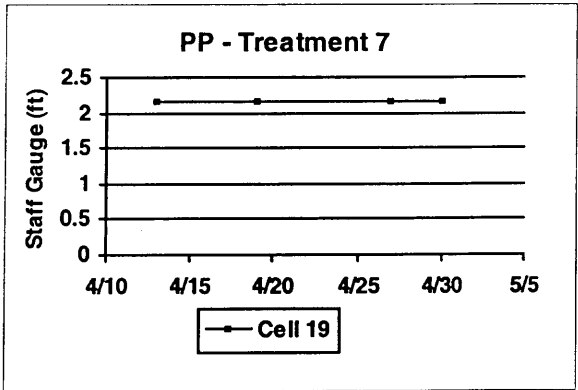
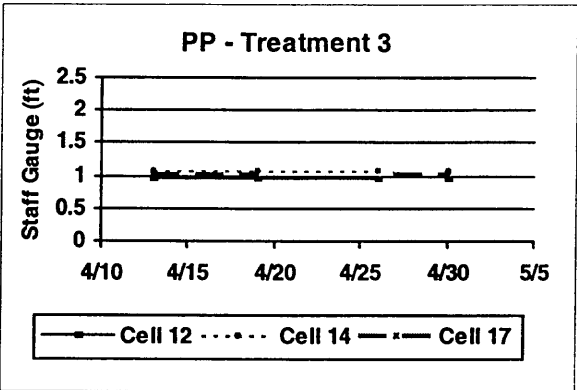
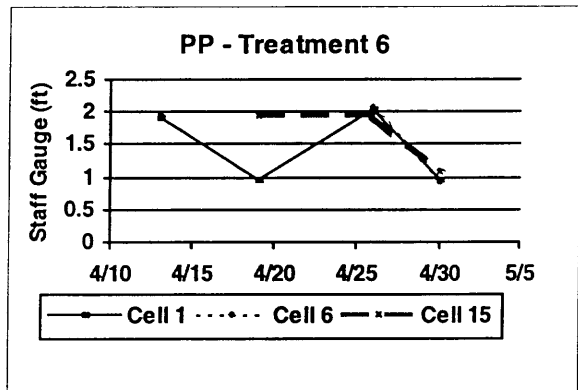
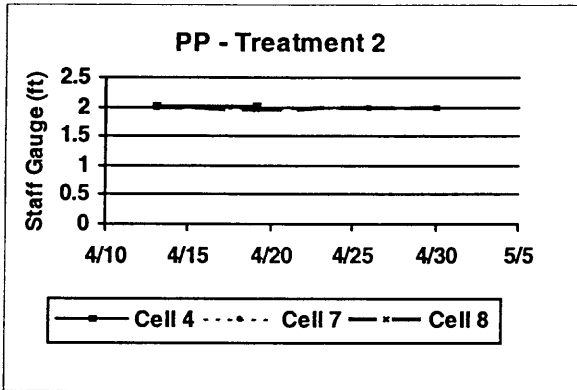
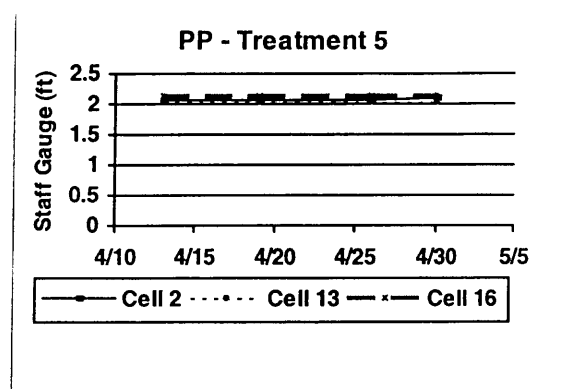
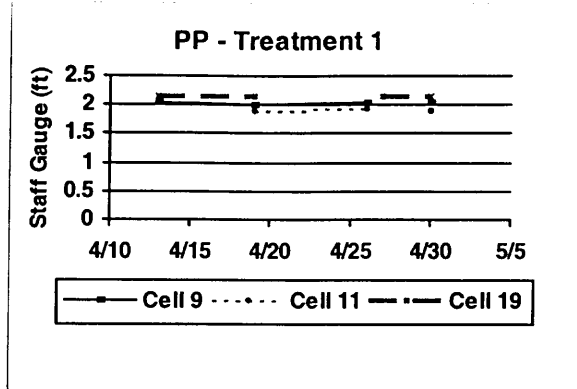


PSTA Test Cell 13



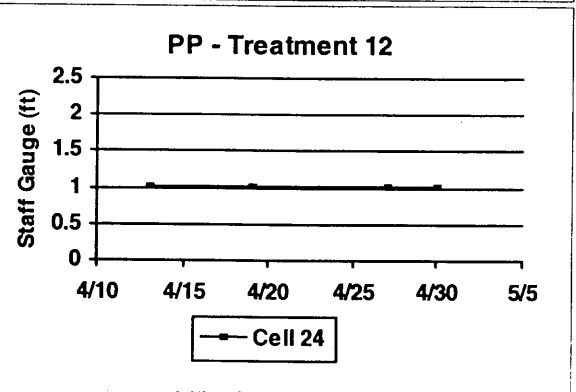
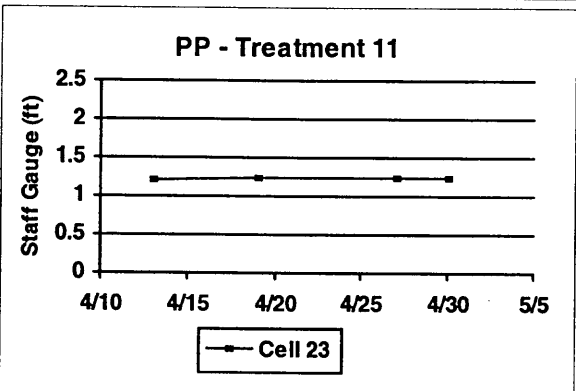
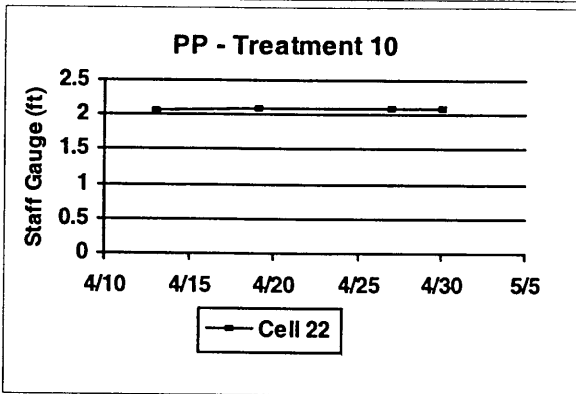
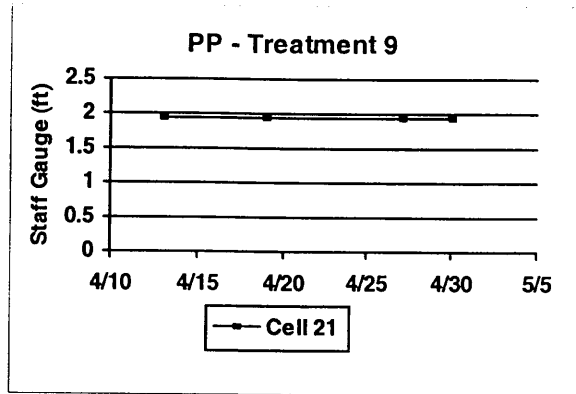
# SFWMD PSTA Research Project

## Porta-PSTA Stage Summary



# SFWMD PSTA Research Project

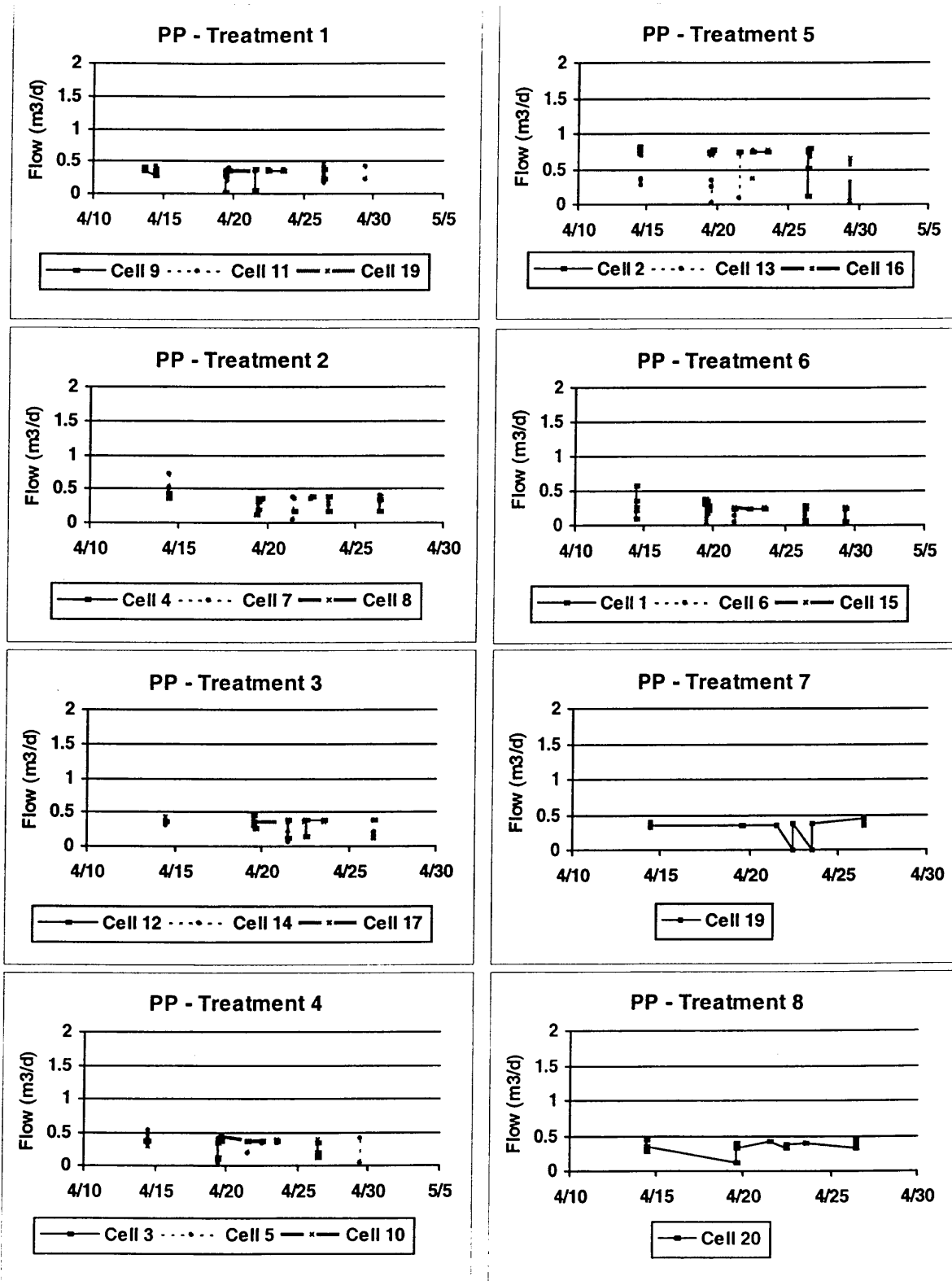
## Porta-PSTA Stage Summary



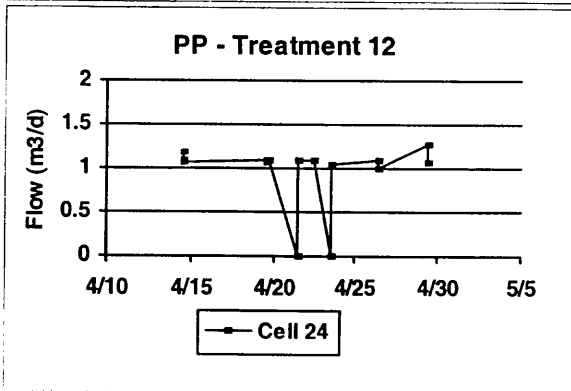
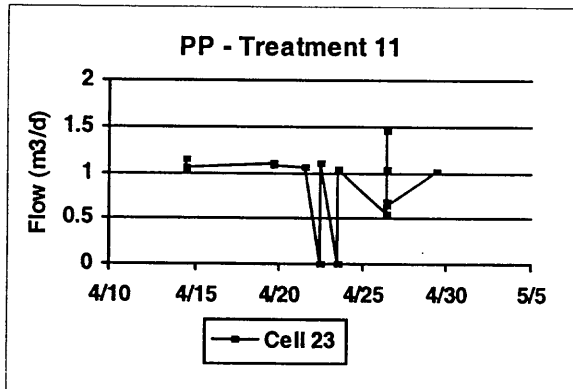
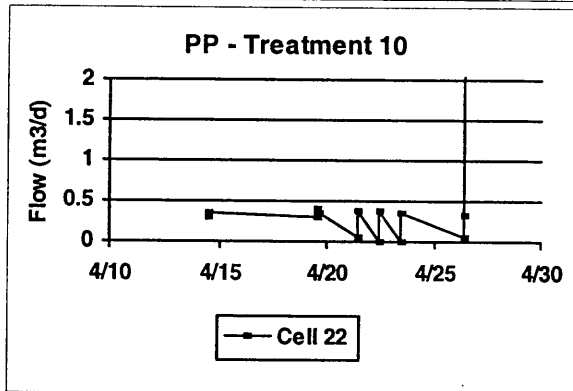
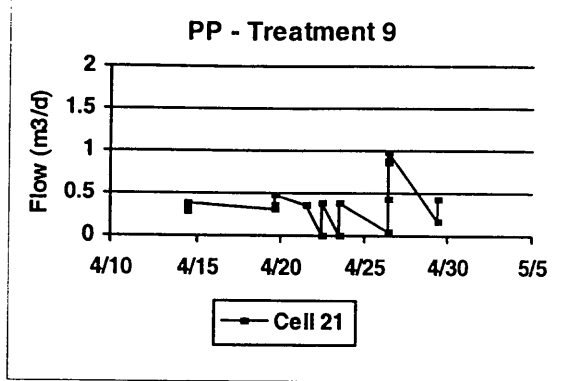


# SFWMD PSTA Research Project

## Porta-PSTA Inflow Summary



SFWMD PSTA Research Project  
Porta-PSTA Inflow Summary



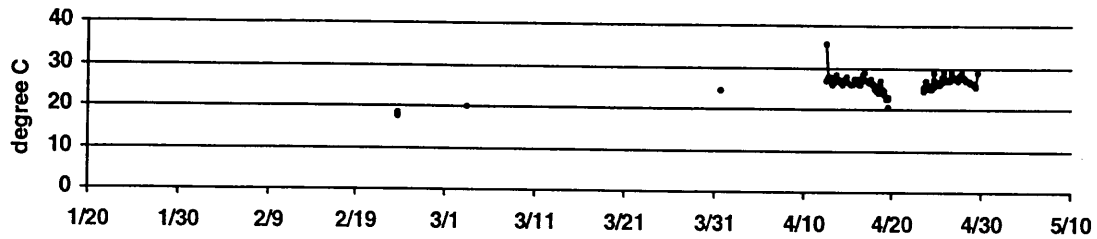
# **PSTA South Test Cells and Porta PSTA Treatments Field Parameter Trend Charts**

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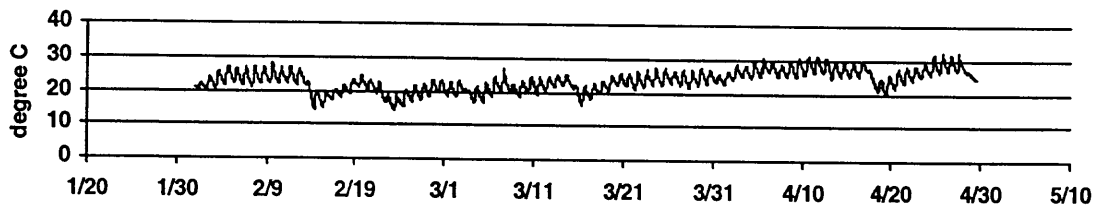
# SFWMD PSTA Research Project Data Summary

## Water Temperature Trend Charts

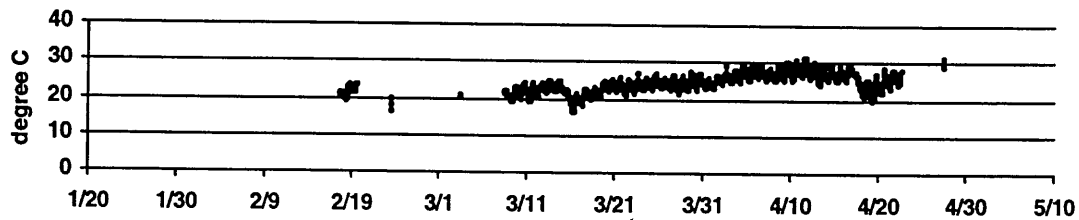
STC - Head Cell



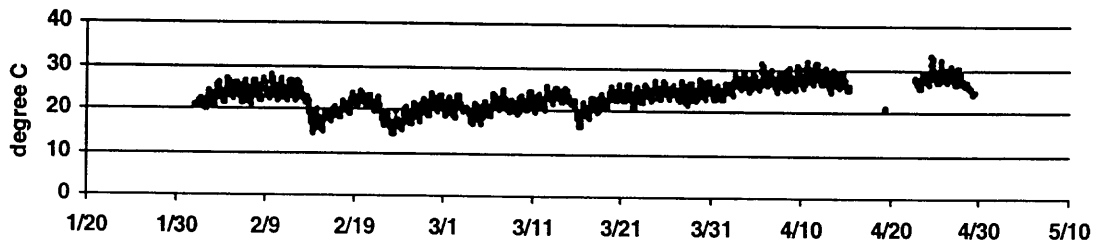
STC  
All Cells & All Stations



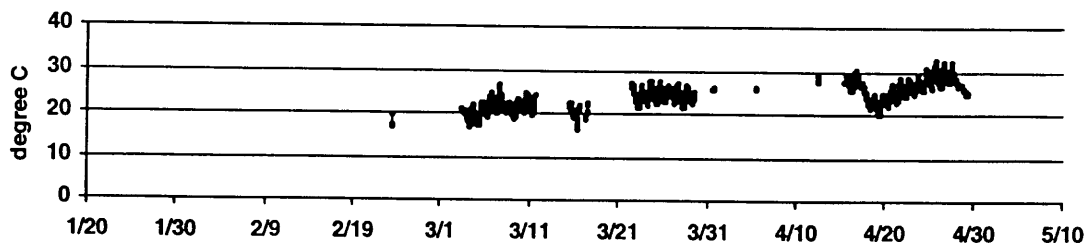
STC - Cell 3  
All Stations



STC - Cell 8  
All Stations



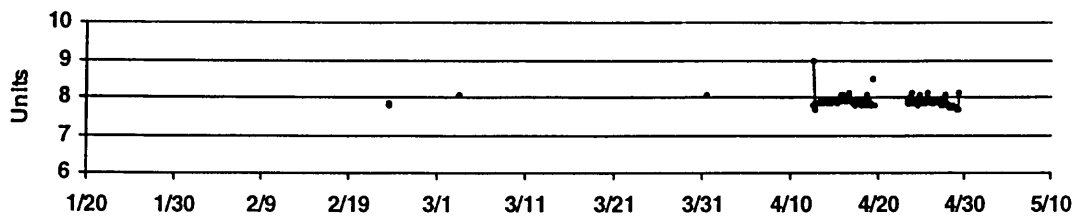
STC - Cell 13  
All Stations



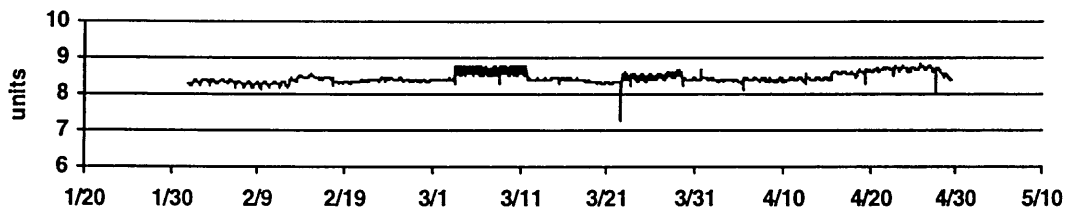
# SFWMD PSTA Research Project Data Summary

## pH Trend Charts

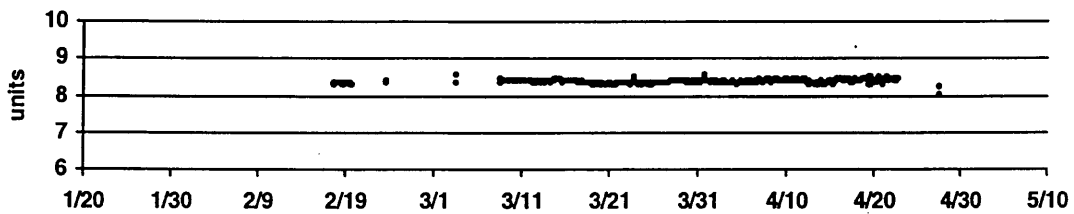
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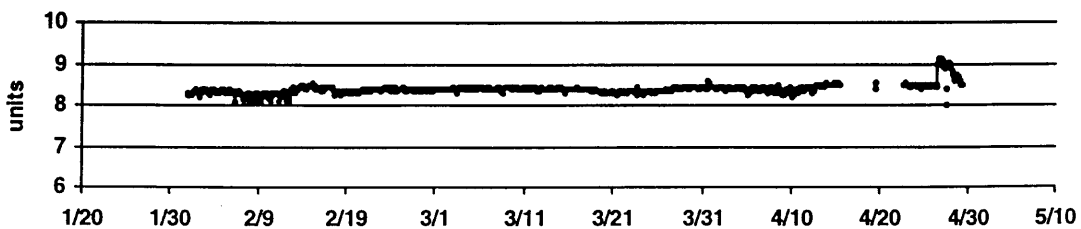
STC  
All Cells & All Stations



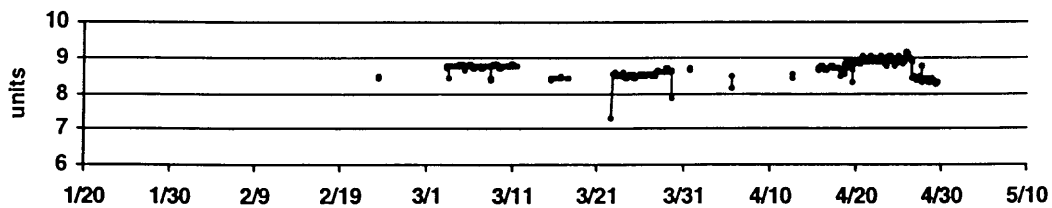
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All Stations



STC - Cell 8  
All Stations



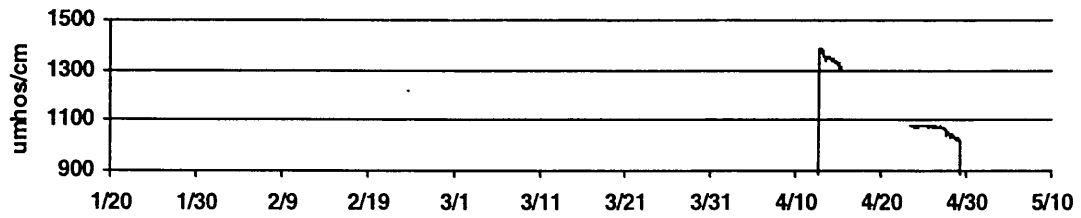
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All Stations



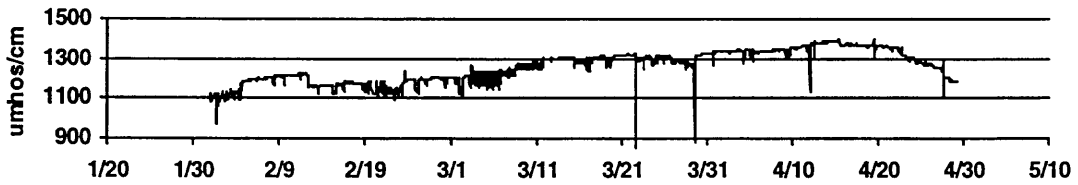
# SFWMD PSTA Research Project Data Summary

## Conductivity Trend Charts

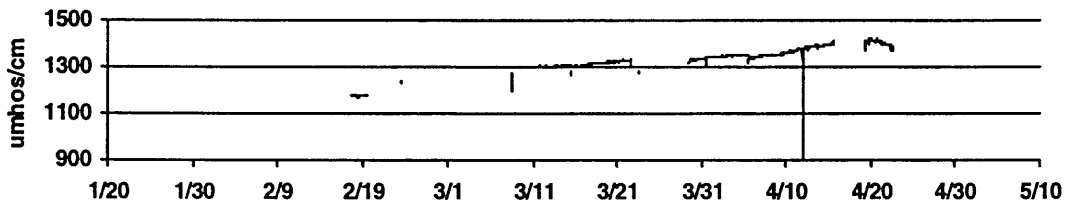
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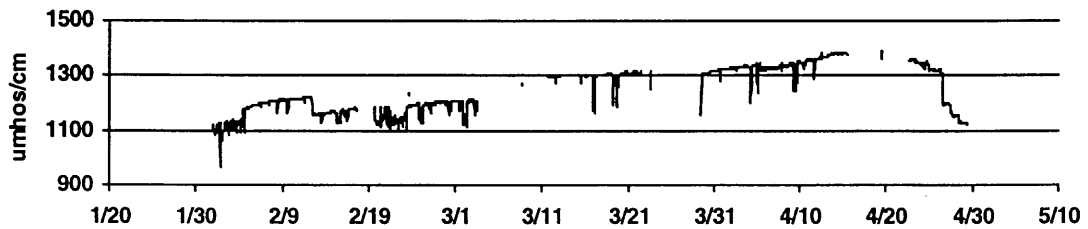
STC  
All Cells & All Stations



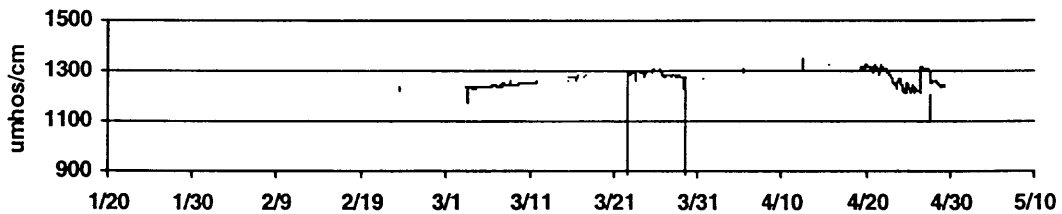
STC - Cell 3  
All Stations



STC - Cell 8  
All Stations



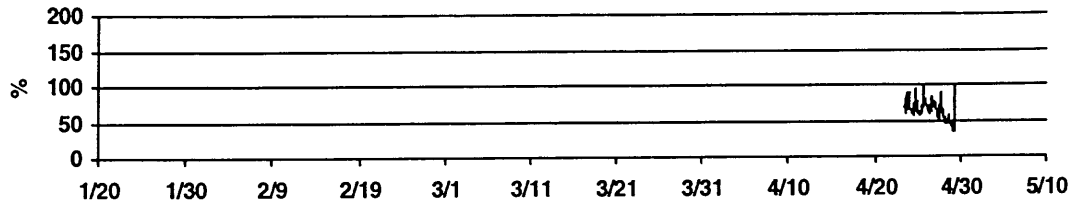
STC - Cell 13  
All Stations



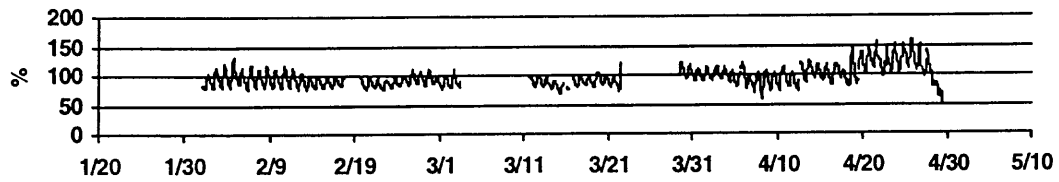
# SFWMD PSTA Research Project Data Summary

## Percent Saturated DO Trend Charts

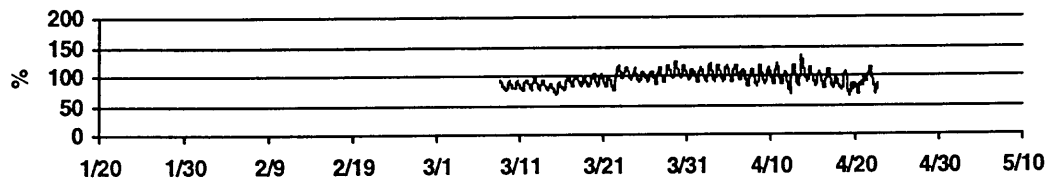
STC - Head Cell



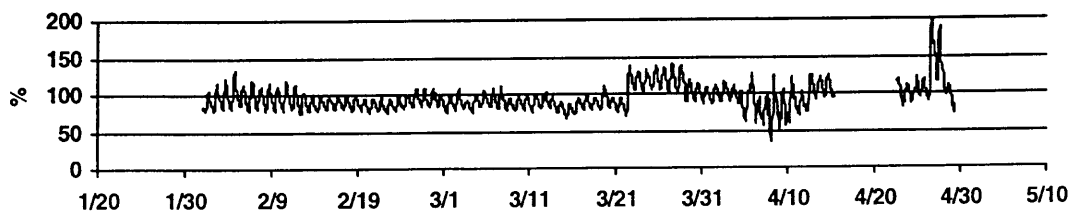
STC  
All Cells & All Stations



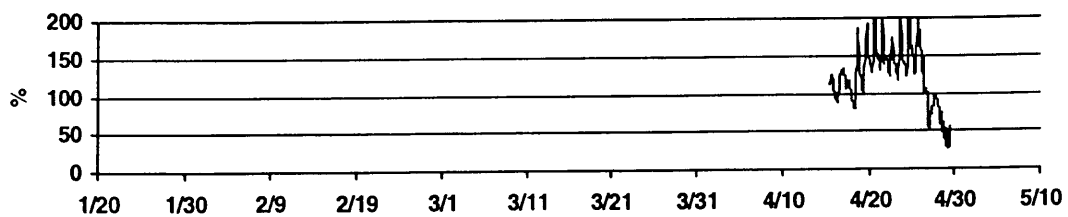
STC - Cell 3  
All Stations



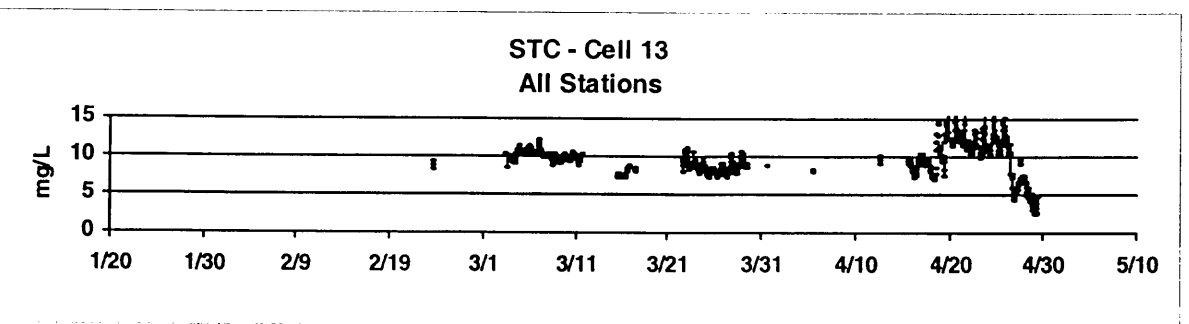
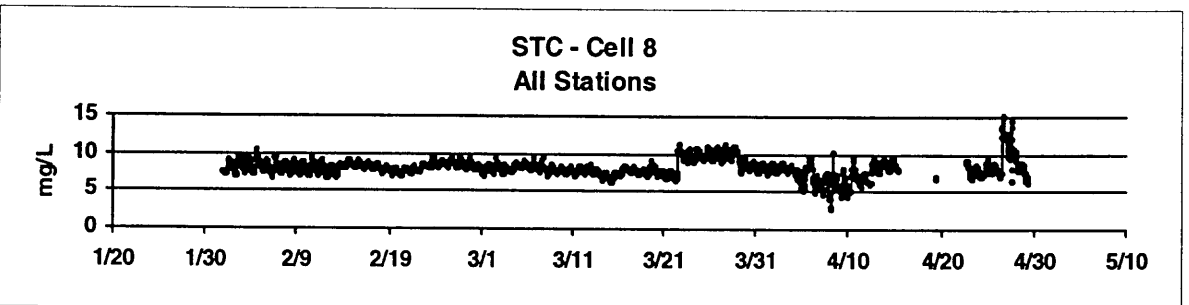
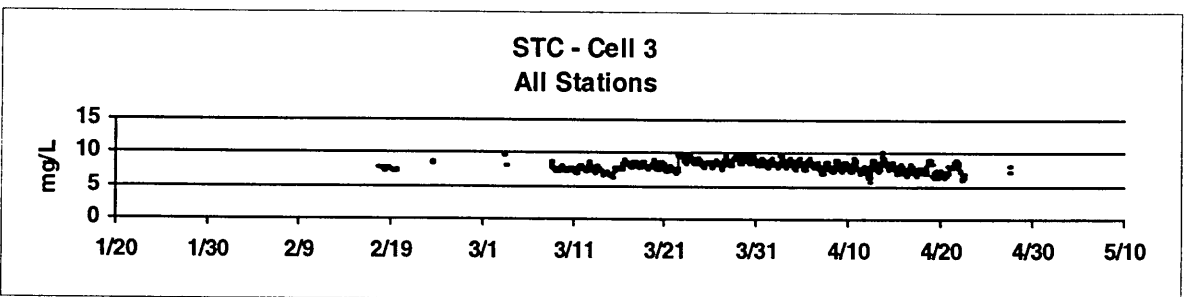
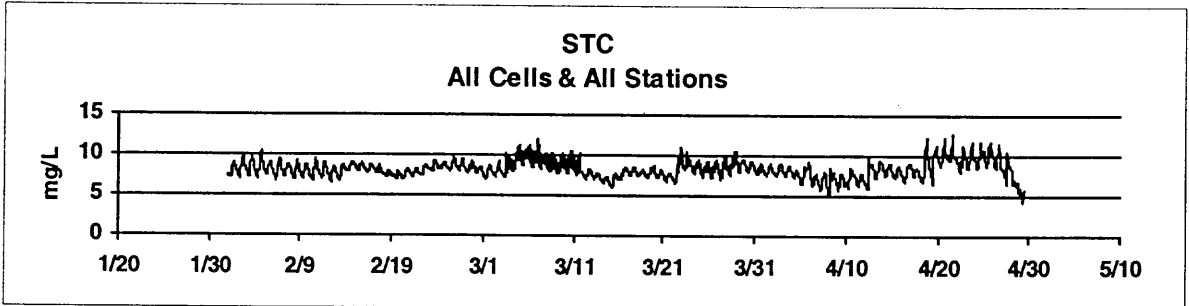
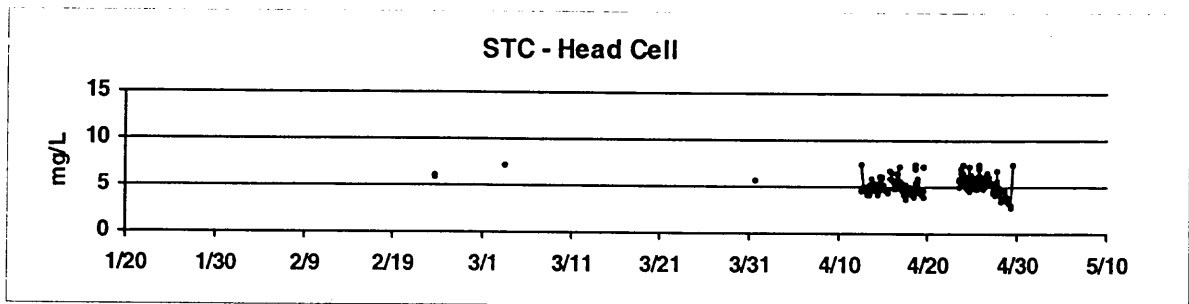
STC - Cell 8  
All Stations



STC - Cell 13  
All Stations



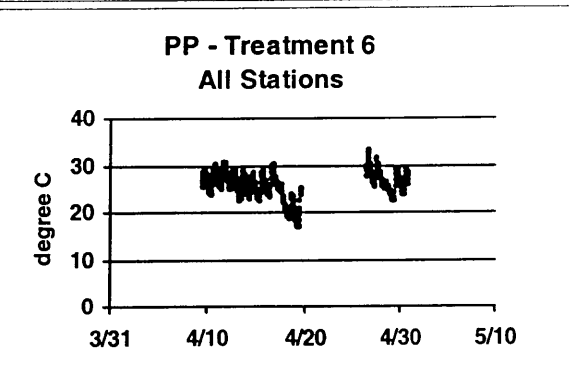
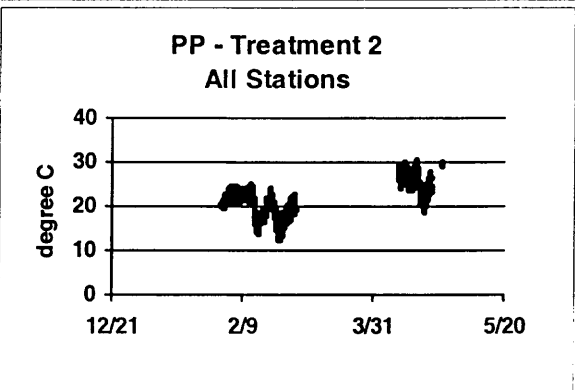
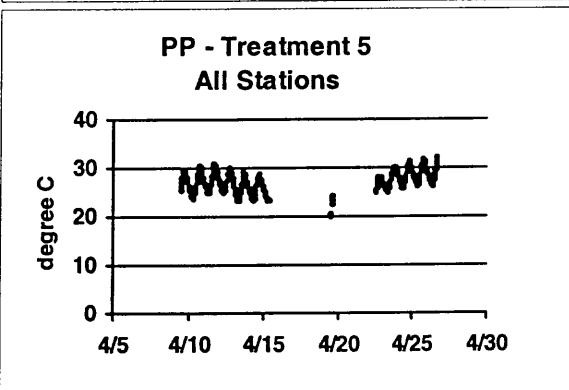
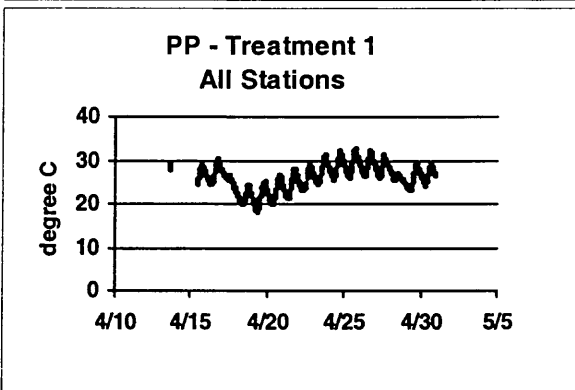
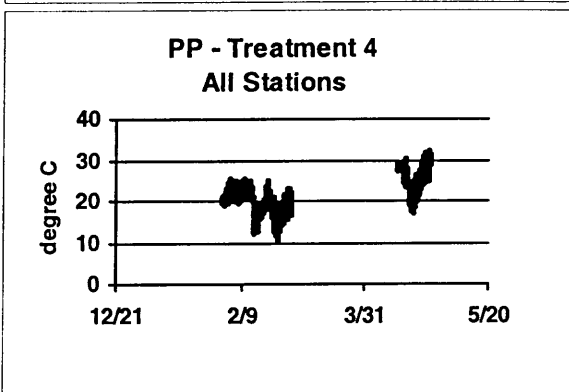
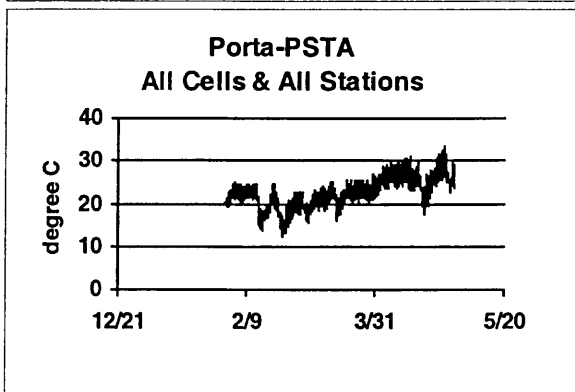
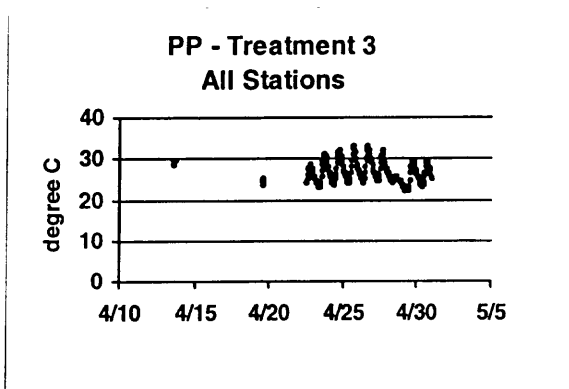
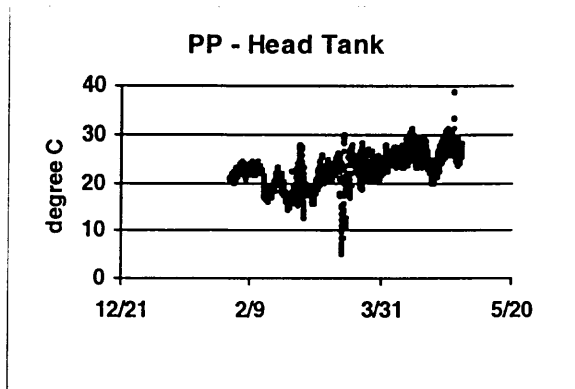
SFWMD PSTA Research Project Data Summary  
Dissolved Oxygen Trend Charts





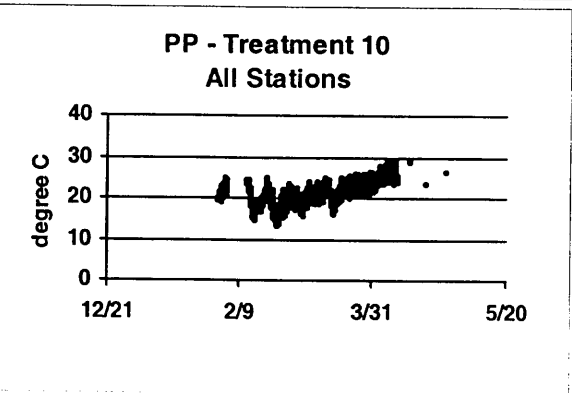
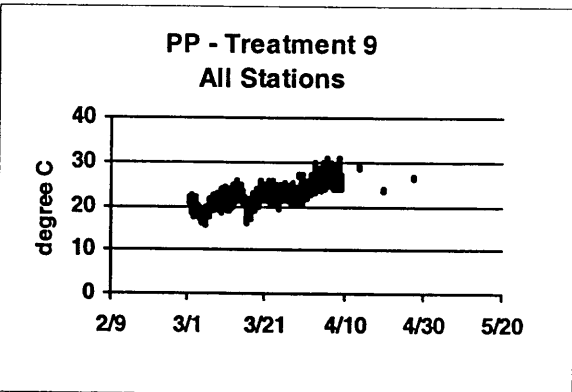
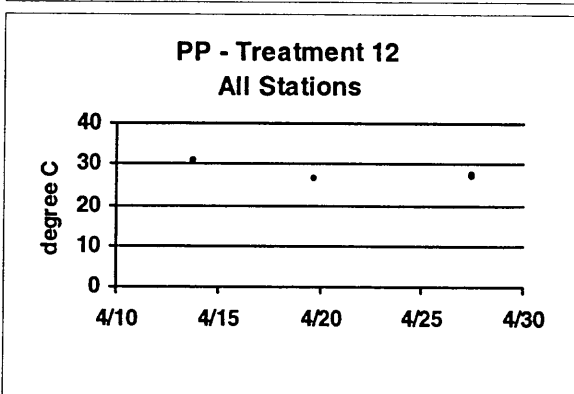
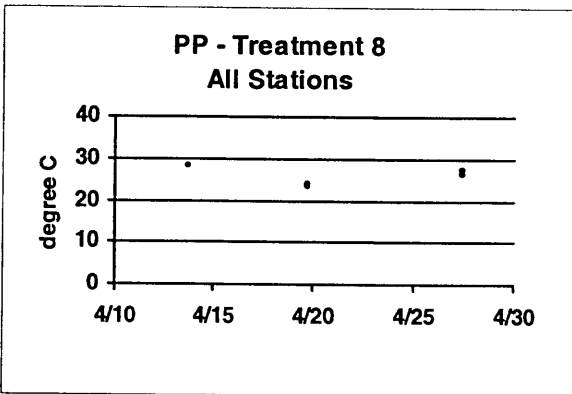
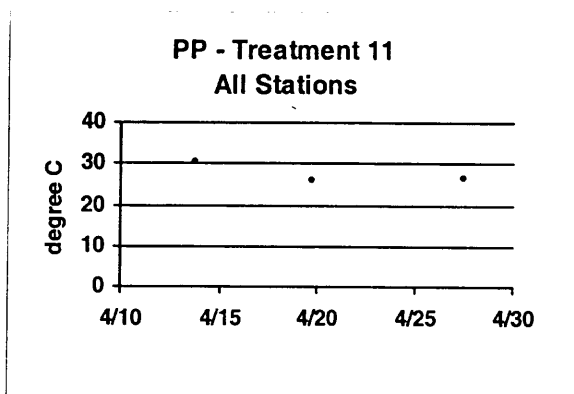
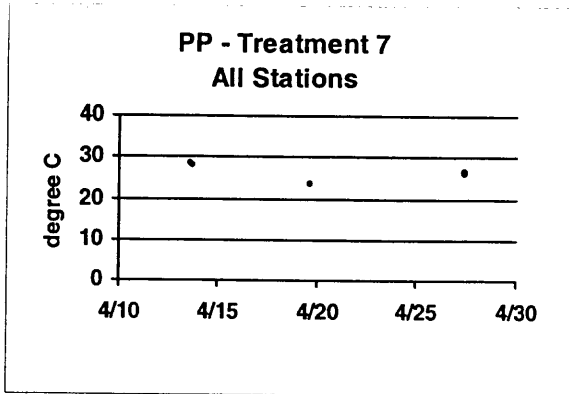
# SFWMD PSTA Research Project Data Summary

## Water Temperature Trend Charts



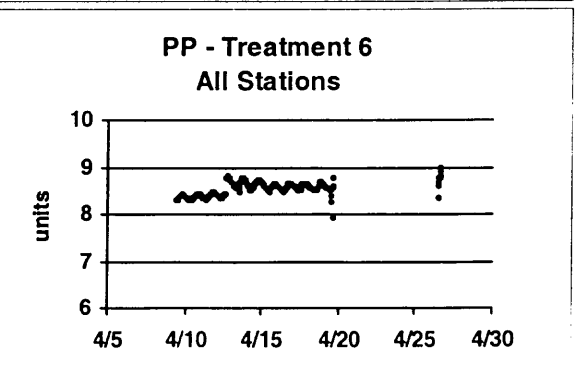
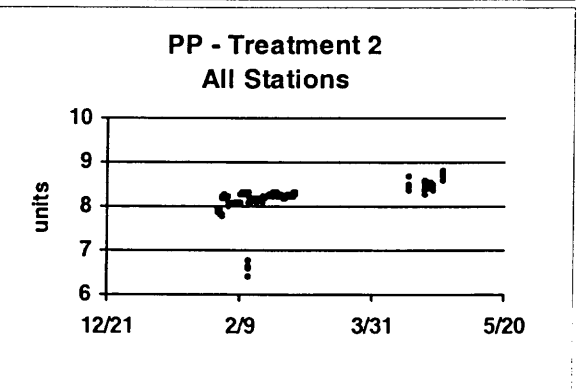
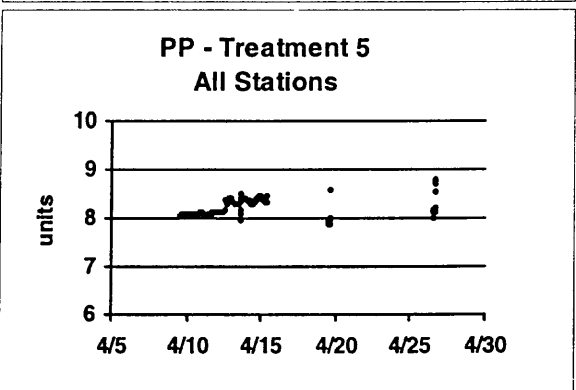
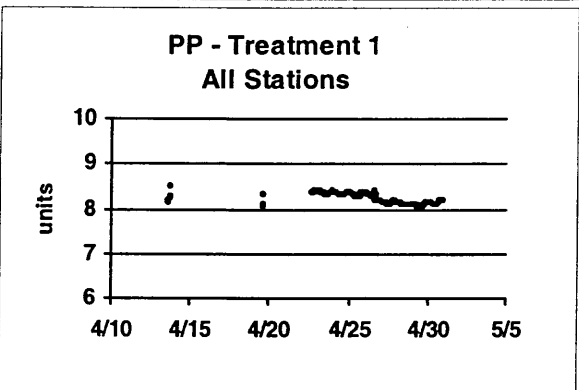
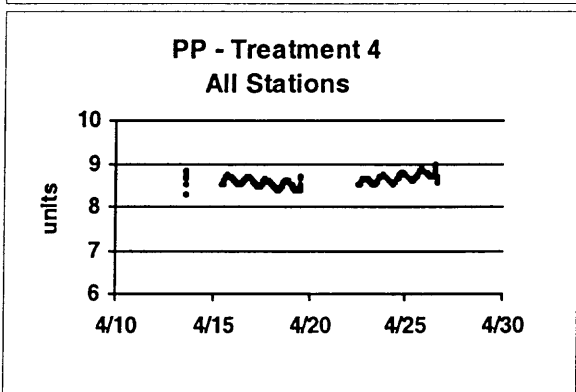
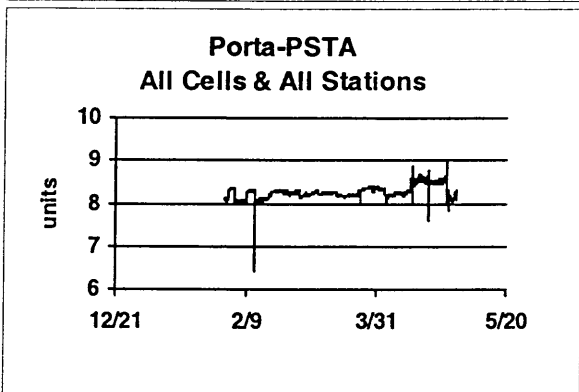
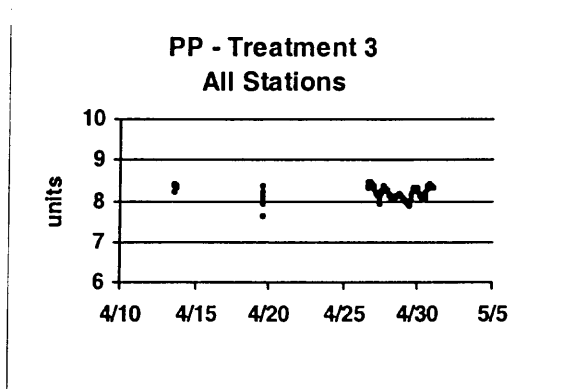
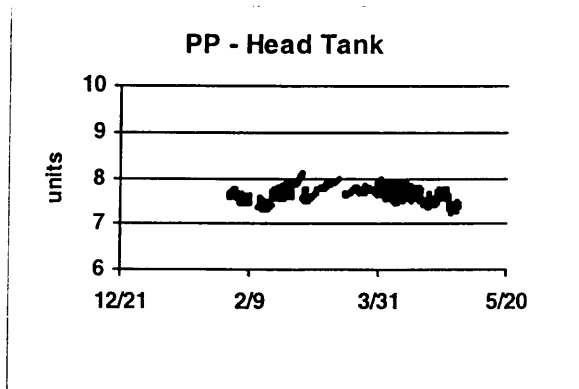
# SFWMD PSTA Research Project Data Summary

## Water Temperature Trend Charts



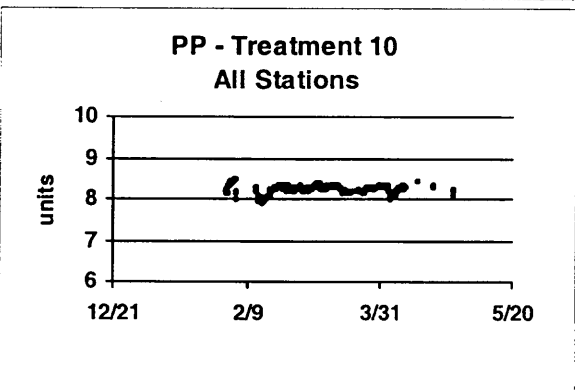
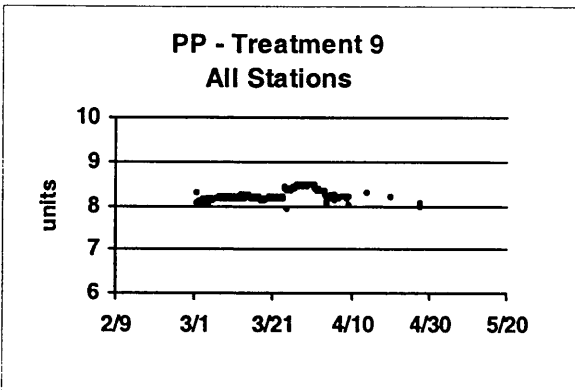
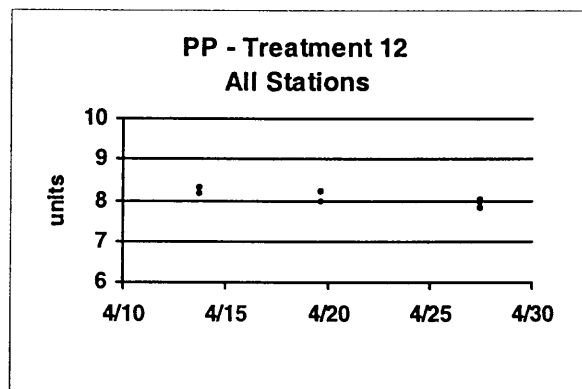
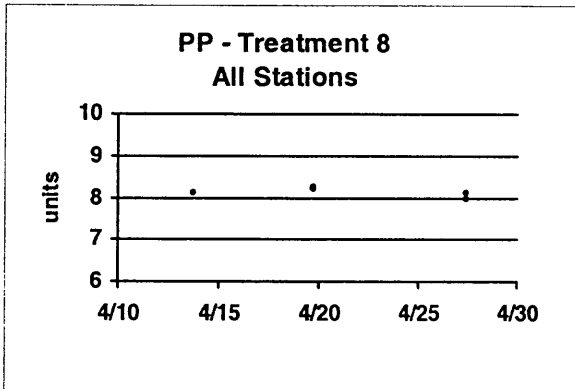
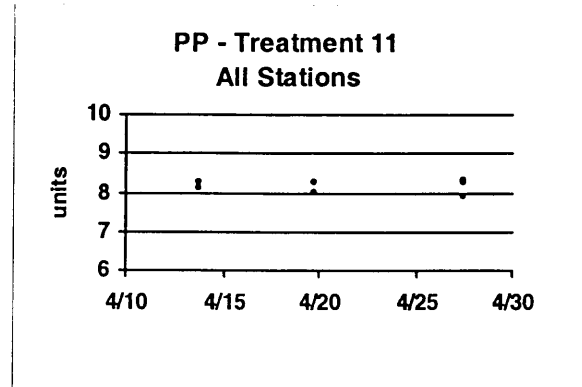
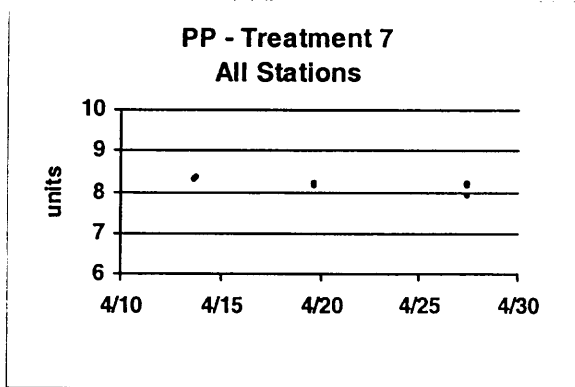
# SFWMD PSTA Research Project Data Summary

## pH Trend Charts



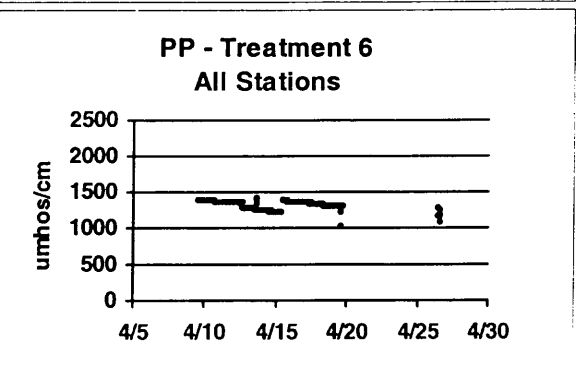
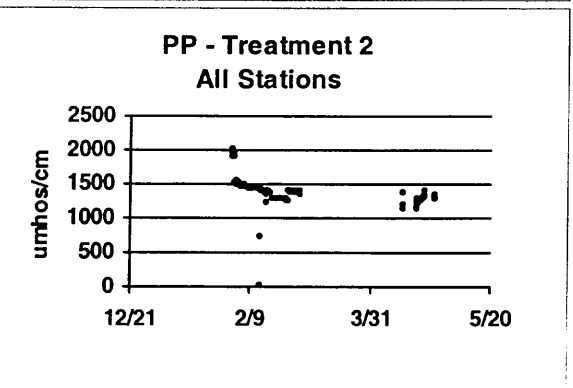
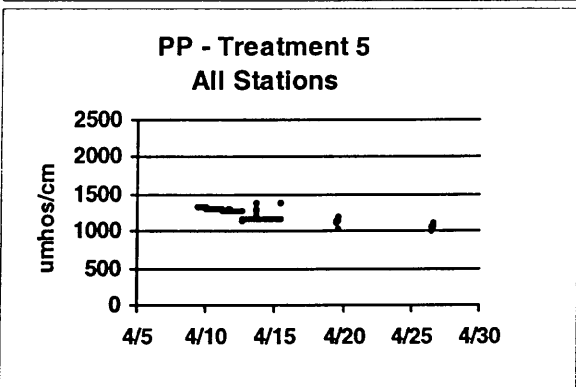
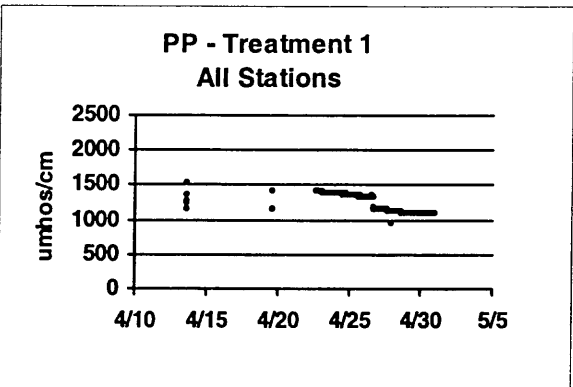
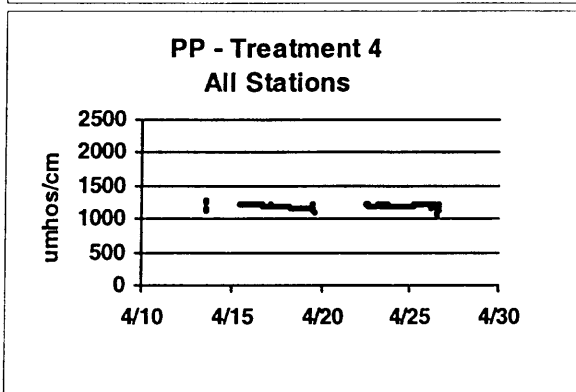
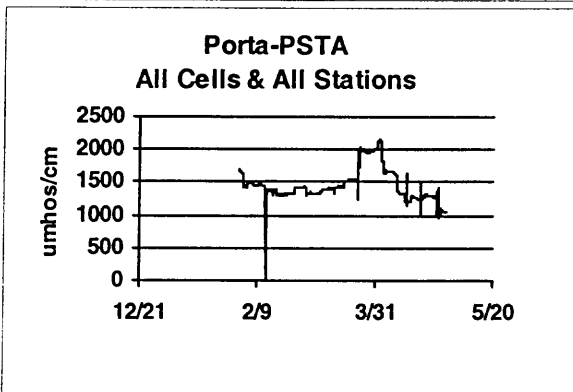
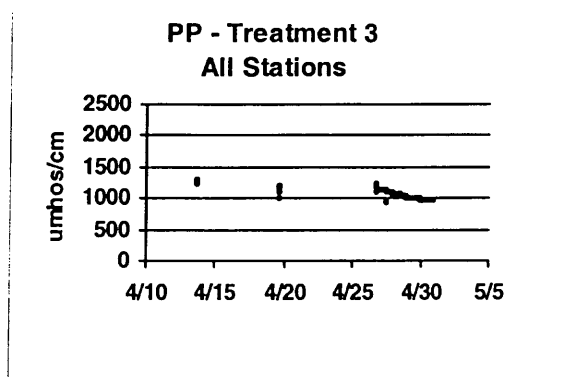
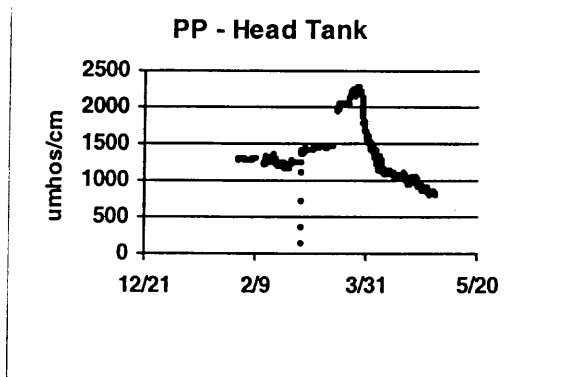
# SFWMD PSTA Research Project Data Summary

## pH Trend Charts



# SFWMD PSTA Research Project Data Summary

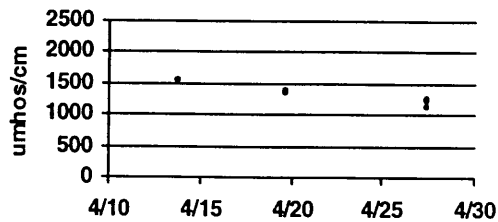
## Conductivity Trend Charts



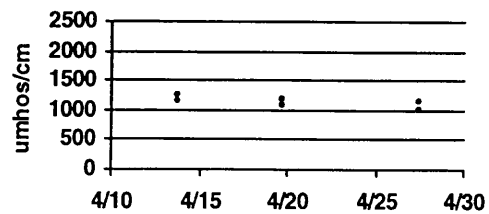
# SFWMD PSTA Research Project Data Summary

## Conductivity Trend Charts

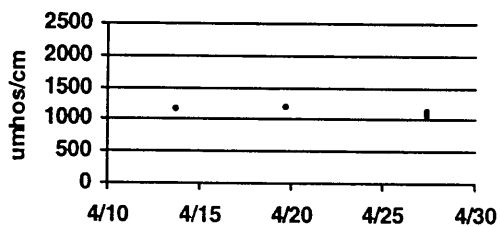
**PP - Treatment 7  
All Stations**



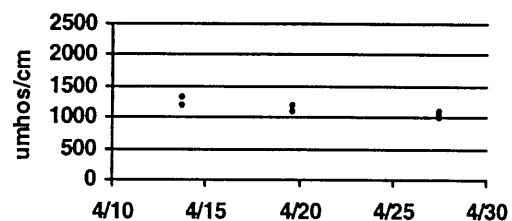
**PP - Treatment 11  
All Stations**



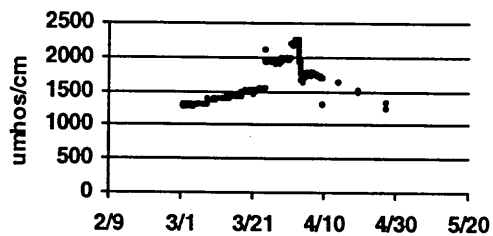
**PP - Treatment 8  
All Stations**



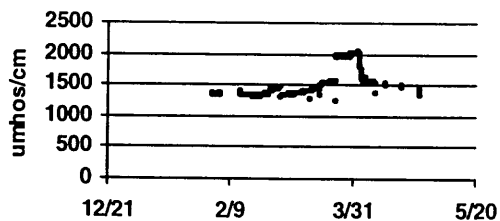
**PP - Treatment 12  
All Stations**



**PP - Treatment 9  
All Stations**

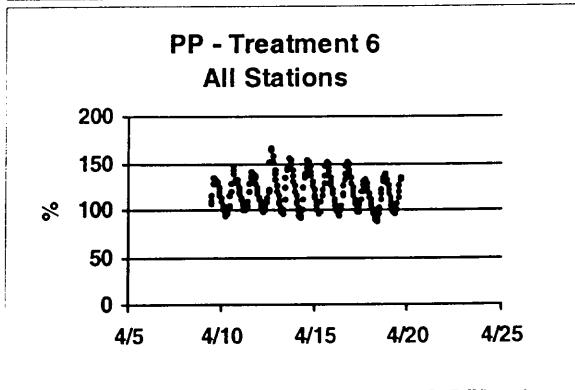
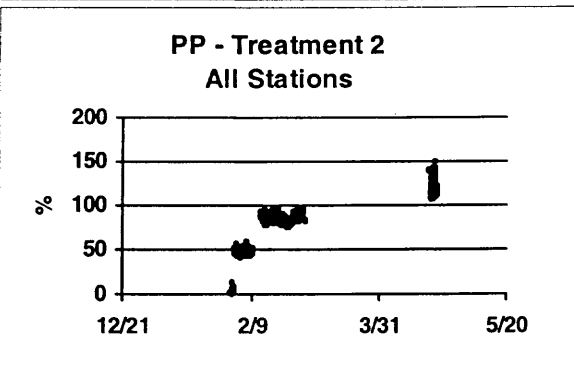
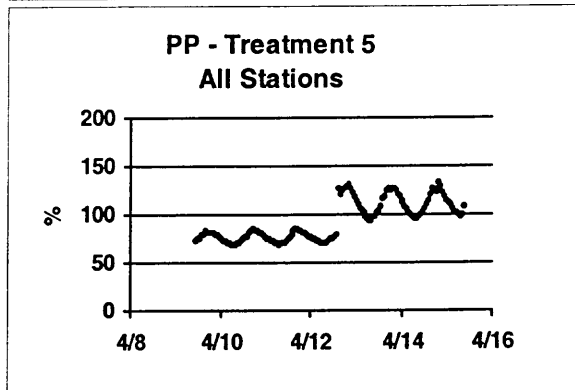
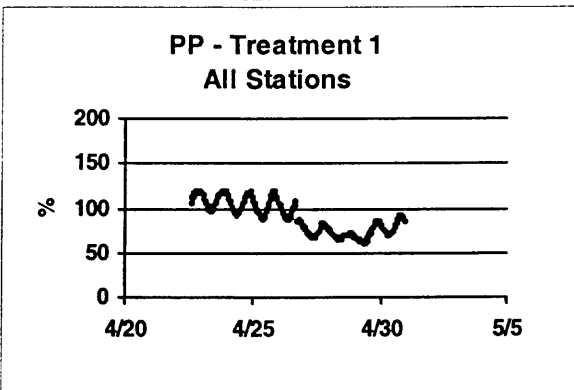
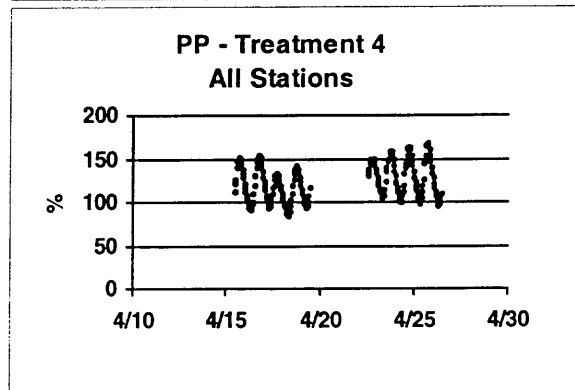
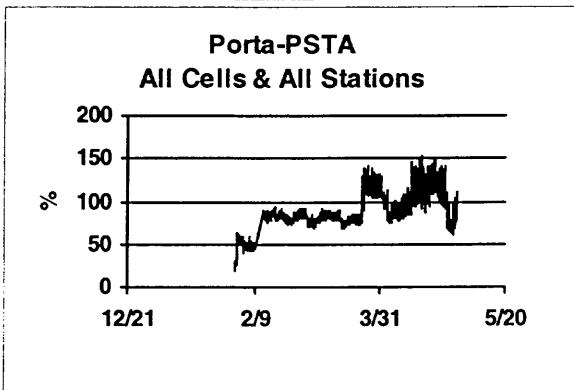
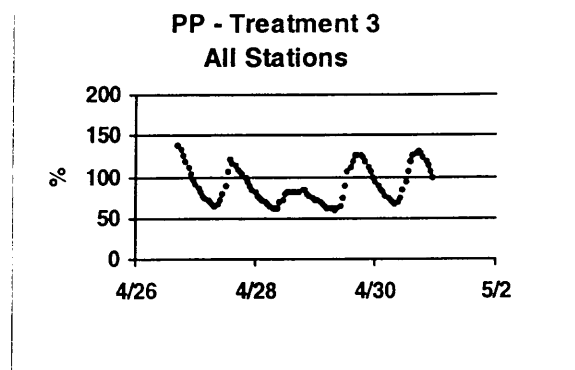
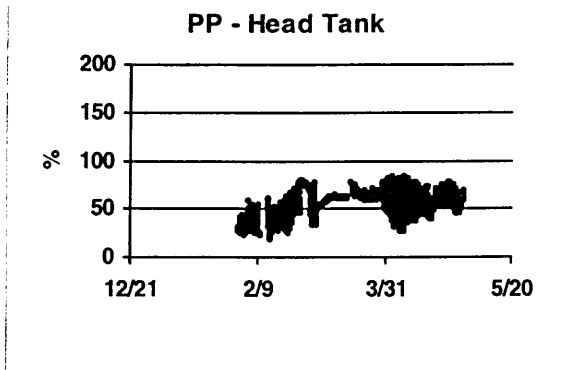


**PP - Treatment 10  
All Stations**



# SFWMD PSTA Research Project Data Summary

## Percent Saturated DO Trend Charts



**SFWMD PSTA Research Project Data Summary**  
**Percent Saturated DO Trend Charts**

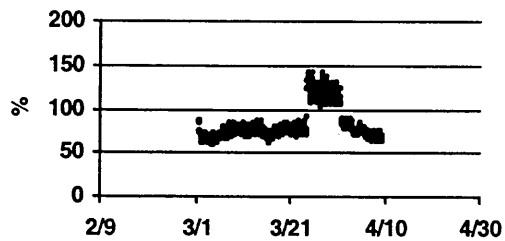
**PP - Treatment 7**  
**All Stations**

**PP - Treatment 11**  
**All Stations**

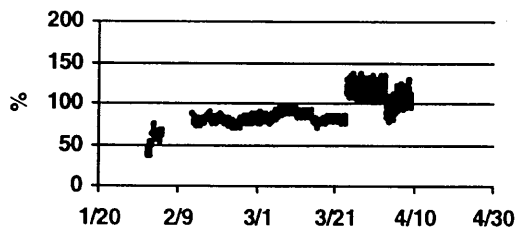
**PP - Treatment 8**  
**All Stations**

**PP - Treatment 12**  
**All Stations**

**PP - Treatment 9**  
**All Stations**



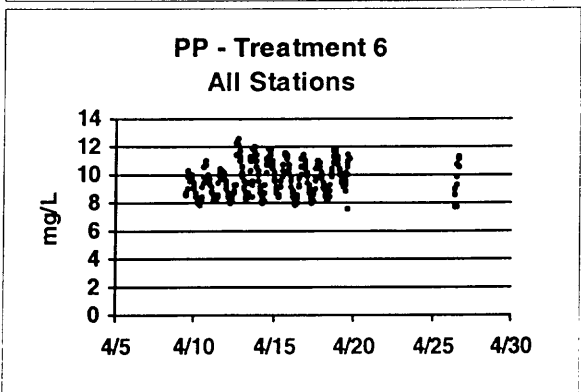
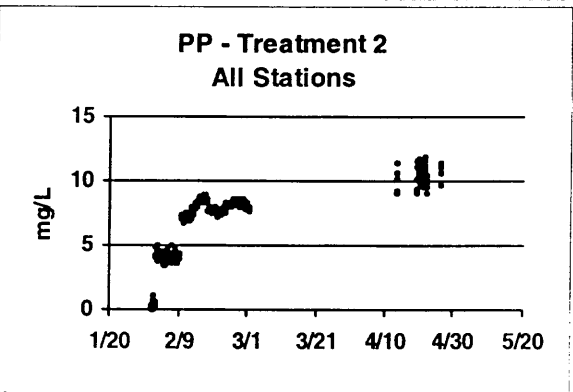
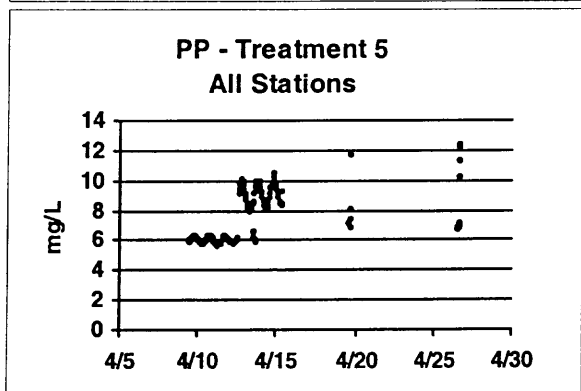
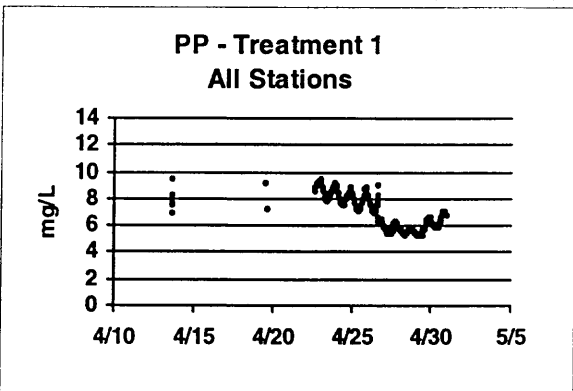
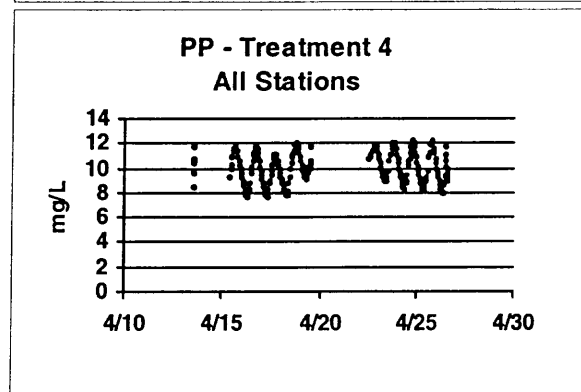
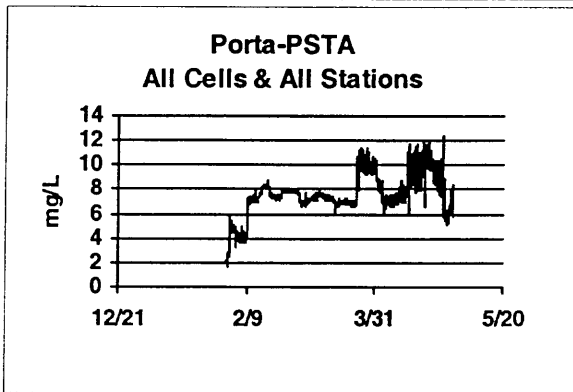
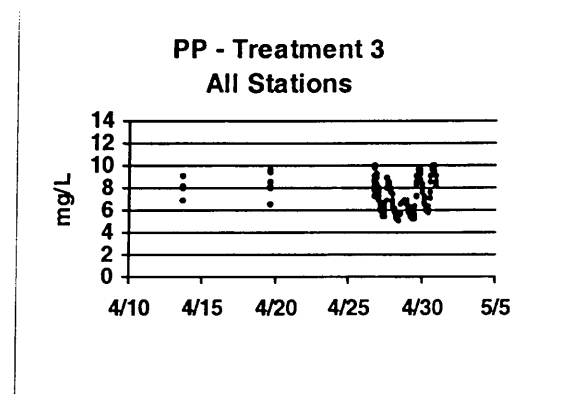
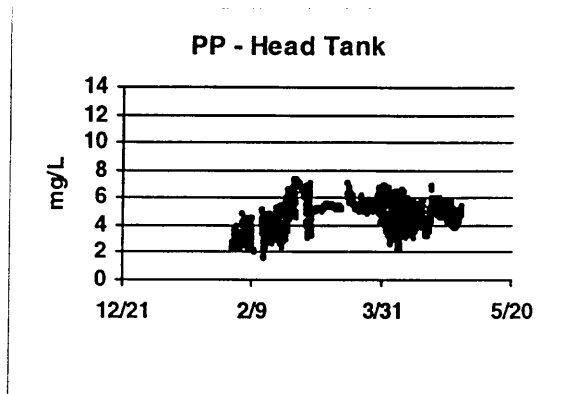
**PP - Treatment 10**  
**All Stations**





# SFWMD PSTA Research Project Data Summary

## Dissolved Oxygen Trend Charts



# SFWMD PSTA Research Project Data Summary

## Dissolved Oxygen Trend Charts

